AUGUST 1955

Power Engineering

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Hardened, Honed Seats

for tough throttling service

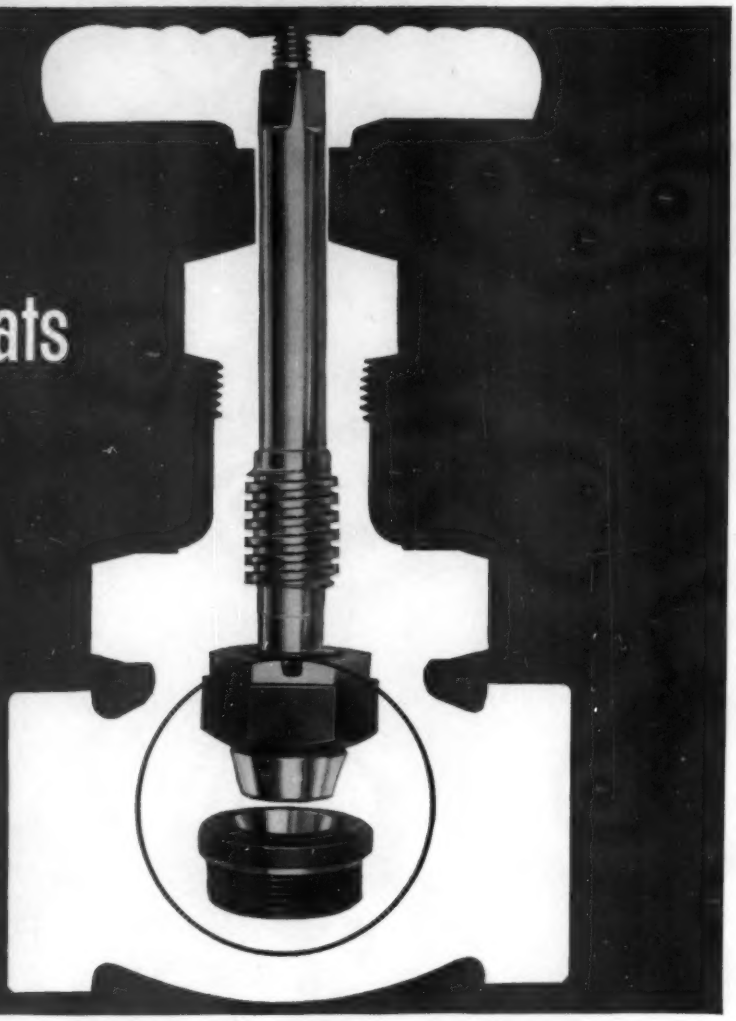


Fig. No. 558, bronze globe valve, 200 lbs. WSP, @ 550°F., 400 lbs. WOG, non-shock

A plug-disc and seat so hard they can crush scale between them and still close tight. A stem that absolutely will not gall or seize. The combination is in a rugged bronze valve designed for tough throttling service . . . the OIC 558!

Both plug-disc and seat are stainless steel, heat-treated to more than 500 Brinell hardness. Their seating surfaces are ground and *honed* to an accurate, smooth, bearing finish. The stem is OIC *alloy-40,* a sturdy bronze which won't gall or seize.

Remember, in throttling service a valve's stem, plug-disc and seat must withstand the most abusive wear. Rely on the toughness designed into this OIC line to give you extra-long service. Specify the modern 558 where you need bronze globe valves for throttling.

Write for Form No. 1001 which describes this valve along with the entire OIC 500 line, including composition disc and spherical disc globes, angles and check valves.

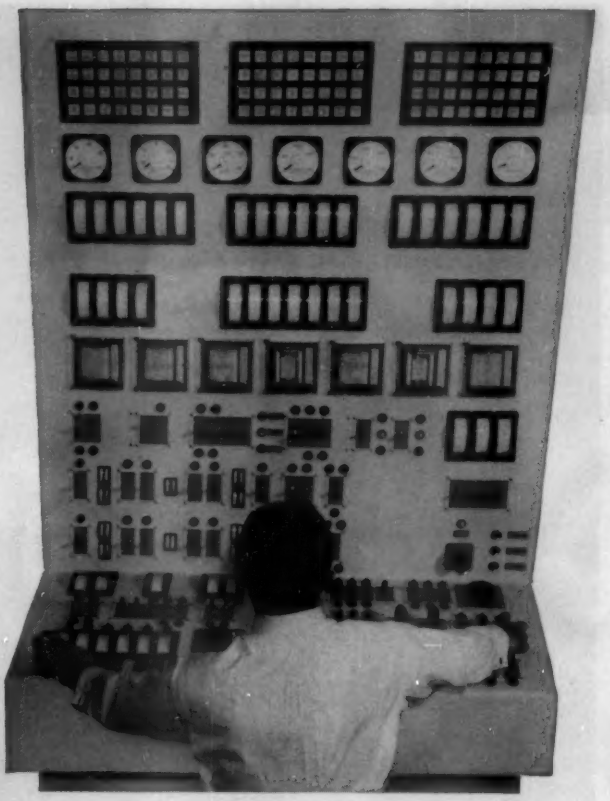
Call your OIC Distributor.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

P-507

VALVES | **FORGED & CAST STEEL, BRONZE & IRON, LUBRICATED PLUG VALVES**

For more data circle 501 on Post Card



NEW DIMENSIONS in boiler plant instrumentation

Controlling a giant boiler, turbine, and generator from a panel 4 feet wide!

At Ninemile Point Plant of the Louisiana Power and Light Company, the new third unit is controlled by the unusually compact B.T.G. control panel shown here. The B.T.G. (Boiler-Turbine-Generator) panel built by Hays is an innovation of Ebasco Services, Incorporated.

Practically every detail of the third unit of Louisiana Power's new Ninemile Point generating plant is of the newest design. An all-weather outdoor boiler with Hays electric type combustion control—gas fired, with provisions for "stand-by" oil firing—will produce over 1,000,000 lbs. of steam per hour, superheated and reheated to 1,005°F.

On outdoor boilers electrically operated combustion control is especially preferred because it doesn't require expensive compressors and dryers, allows maximum freedom in control room location. For greater speed of response and accuracy new Hays electronic instruments, including electronic mercury-less flowmeters and 3 element electronic feed water control are being installed.

Among the central stations recently selecting Hays instrumentation and control are: Jersey Central Power and Light Co., Northern Indiana Public Service Co., Central Illinois Electric and Gas Co., St. Joseph Power and Light Co., Crawfordsville Power and Light Co.

Write for Hays Boiler Plant Instrumentation Bulletin 54-605-83.

THE **hays** CORPORATION

MICHIGAN CITY 7, INDIANA

Automatic Combustion Control • Venturi Meters and Venturi • Electronic Oxygen Recorders • CO-Recorders Boiler Panels • Gas Analyzers • Combustion Test Sets Draft Gages • Electronic Flowmeters • Miniature Remote Indicators • Electronic Feed Water Controls

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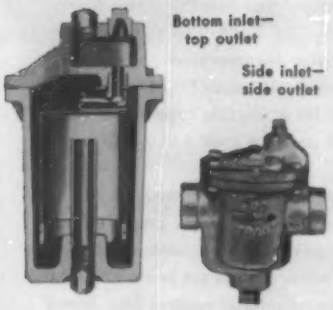
The Steam Trap with a Heart of "Gold"...



Corrosion- and wear-resistant materials; "frictionless" leverage; precision workmanship — add up to LOW MAINTENANCE.

The exterior of the Armstrong trap pictured above sure looks rough, but inside it has a heart of "gold" for its owner, Chemicals, Inc., Chicago, makers of zinc chloride.

Fuel Saving—coal consumption has been cut ½ carload per month since installing Armstrongs to drain kettle coils.

Time Saving—processing time has been cut from 5 days down to 3 days on one zinc chloride tank since installing an Armstrong trap on each of its three coils.

Maintenance Saving—occasionally holes are eaten right through submerged steam coils, allowing acid to get into traps. The stainless Armstrong mechanisms have withstood this abuse successfully. Trap maintenance generally has been negligible. The trap shown above has been on the job working perfectly for five years without repairs.

Take a tip from Mr. Stanley Nykiel, plant operator, who says *"I've tried other kinds, but Armstrongs work best."* Call your local Armstrong Representative (see classified directory or Thomas Register) or write:

ARMSTRONG MACHINE WORKS
810 Maple Street • Three Rivers, Michigan

Application Engineered

ARMSTRONG STEAM TRAPS

SEND FOR CATALOG J

The 44-page Steam Trap Book gives complete trap data and prices plus useful selection, installation and maintenance information. Armstrong traps also catalogued in Sweets and Chemical Engineering Catalog.

513

For more data circle 503 on Post Card

ENGINEERS' PREVIEW

LARGEST RHEOSTAT of its kind in the world, able to dissipate 3300 kw, has been built by the General Electric Co.'s Industry Control Department for the Air Force's Arnold Engineering Development Center, Tullahoma, Tenn. Ordered by Foster Wheeler Corp., the rheostat will be incorporated into a wind tunnel installation by Consolidated Western Steel Division of U. S. Steel.

The rheostat will be used to vary current passing into giant heaters that regulate temperature of air passing through the test section of the wind tunnel. The heated air, driven by compressors, makes possible tremendous velocity. As a result, hypersonic wind conditions are available for testing aircraft models that travel at unusually high speeds.

Weighing 40,000 lb when full, the rheostat has three pumps that force 225 gal of electrolyte per minute each. Contrary to normal practice where the wye point is grounded, the rheostat is built so that each phase is insulated from the other two phases. Large mounting bushings insulate each phase from ground.

• • •

COOL CALCULATION! More than 5,000 electronic tubes in the Univac — Remington Rand's electronic computer — being installed at the Franklin Life Insurance Co., Springfield, Ill., produce over 400,000 Btu of heat per hour. This is enough to heat 20 average-size six-room homes! To maintain adequate operating temperatures, a Worthington liquid chiller refrigeration unit will furnish cooling equivalent to 60 tons of ice per day. The installation is one of the first for private commercial use.

• • •

Mrs. Lois McDowell, assistant professor of mechanical engineering, Illinois Institute of Technology, is the new president of the Society of Women Engineers (1955–1956). Many of you who attended the recent American Power Conference will recall Mrs. McDowell's participation and interest.

• • •

WESTINGHOUSE RESEARCH scientists now make "perfect" iron. Pure and perfect slivers of iron, having breaking strengths approaching a million pounds per square inch — far greater than any other known metal — have been produced on an unprecedented scale. Dr. J. A. Hutcheson, vice president and director of Westinghouse research, discloses that the slivers of iron, or "whiskers" as they are called, are each a pure iron crystal so perfect that no defects can be detected in its structure. The crystals are as much as 2 in. long and a thousandth of an inch thick. Previous attempts to produce these "whiskers" have given crystals which could be observed only with the aid of a microscope.

• • •

ROBERT S. STEVENSON has been elected president of Allis-Chalmers Manufacturing Co., Milwaukee, Wis., by the board of directors to succeed the late William A. Roberts, who died April 12. Stevenson has been executive vice president of the company since July, 1952.

He started with Allis-Chalmers in 1933 as a salesman in the Tractor Division at the Kansas City, Mo., branch, then served in many managerial capacities.

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PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

LETTERS TO THE EDITORS

Handling Heavy Fuel Oil

MR. KOEPF'S article, in your April 1955 issue, entitled Handling Heavy Fuel Oil is an Art, is excellent but requires a few additional notes.

1. All oil-containing spaces which can be completely closed off by valves or other fixtures should have pressure relief valves to guard against over pressure from expansion of oil if the valves should be closed and the temperature of the enclosed oil rise, as has been known to happen. The arrangement described by Mr. Rogers in the same issue, in connection with the oil supply for Astoria Station (See April, page 72) in which each such relief valve discharges back into the next preceding section towards the supply tank, is a very neat way of eliminating the possibility of a messy discharge should circumstances require the pressure relief valve to operate. Where there is a circulating return line, the relief valves usually discharge into it.

2. Regarding pipe sizing, design from hydraulic formulas is desirable, but operating experience with cold starts and other abnormal conditions has shown that suction-line velocities, where the oil tank is below pump level, should be held to ½ to 1 fps and, for oil tanks above pump level, to 1 to 1½ fps.

3. In our eastern coast territory, it cannot be said that most large boilers (above 400 hp) use steam atomization. The choice between steam and pressure atomization is greatly influenced by the nature of the load as steam atomizing burners have a wider range of capacity with the same amount of attention by the operator. There are a substantial number of installations of each type of equipment.

4. Recommended viscosities by representative manufacturers for each type of equipment are: Steam atomizing burners — 200 SSU; pressure atomizing burners — 150 SSU; spinning cup burners — 700 SSU. *H. D. Fisher, New Haven, Conn.*

Writer Thinks Reiter Right on Ash Fusion

MR. REITER'S UTILIZATION of the color of the cinder or ash as a guide to the relationship between the ash-fusion temperature of the coal being fired and the actual temperature of combustion, is of considerable interest.* Under normal continuous operation of a fairly constant load, this works out very well. But with a variable load on the boiler and stoker, another factor enters the color reactions.

Recent tests in sintering coal fly ash revealed that the atmosphere surrounding the ash affects the color to a marked degree. In a highly oxidizing atmosphere, the color of the ash was a light brown. When the atmosphere was made very reducing, the material fused more quickly and turned black. Laboratories perform their ash-fusion tests in reducing atmospheres in order to simulate normal coal furnace conditions and to give lower ash fusing temperatures.

The iron atom is amphoteric, shifting back and forth between its black ferrous state that exists under reducing atmospheres, and the brown ferric compounds that exist when oxidized. A boiler may operate with excess air, oxidizing, under light loads, and change to reducing conditions of insufficient air under heavy loading. At the same time, the ash fusion temperature of the ash is lowered to meet the rising temperature of the accelerated rate of firing. This combination can be the source of excessive clinkering and fusion. The color of the ash, as Reiter points out, becomes the advance indicator of all of these deleterious secondary ash reactions that will lead to trouble.

Our tests were run with coal ash analyzing approximately 50 per cent SiO_2, 30 per cent Al_2O_3, 3 to 9 per cent combustible, and from 5 to 10 per cent Fe_2O_3. This ash was processed through a rotary cement type kiln. When the atmosphere went reducing, fusing rings began to form in the hot zone, maintained at about 2300 F. The material began to turn greenish and then to blacken when the atmosphere became distinctly reducing. When the atmosphere was returned to oxidizing, the fusing lessened, and the color returned to light brown. The term "fusing" in our tests meant becoming pyroplastic, a condition that would compare with a point between the "initial deformation" and the "ash softening" temperatures of laboratory coal ash fusion tests. The surfaces have just vitrified. The kiln-firing fuel was natural gas, so that the color change was not due to contained carbon, but rather to the iron.

We can concur in Reiter's suggestion that the color of the cinder or ash coming from a boiler can serve as an indicator as to what is occurring in the firing of the coal, in terms of load, temperature, atmosphere and fusion; as a guide to the results accumulating from these complex reactions. Knowing the various reactions involved, in general terms, better control of the end results can be maintained. — *C. W. Stevens*

* *Editors' Note:* Mr. Reiter's article, How Sulfur Content of Coal Relates to Ash Fusion Characteristics, appeared in the May, 1955, issue of POWER ENGINEERING.

We Are Looking for Editors

POWER ENGINEERING is expanding and will have openings for graduate engineers in the mechanical or electrical field with a good solid background of operating, design, and construction experience. If you like to travel, meet people, learn of new developments, investigate new ideas, and if you have imagination, ingenuity and tact, together with a reasonable command of the King's English, you will find this interesting work. There are several openings, but the immediate one has the following specifications:

A graduate engineer from 45 to 50 years of age, who has gone through a cadet or student engineer's course with one of the public utilities, spent a number of years in the operating department, two or three years in the power sales department, and a number of years as power engineer with industrial companies, and who holds a professional engineer's license.

Not all engineers like to be editors, but the engineers who are editors feel it is a great profession. If you meet the specifications, or, as a potential associate editor, can fit into one of the several steps in the specifications, will you write, giving complete details of your education and experience, to an engineer who has been in the business for a generation? Write to the Editor, POWER ENGINEERING, 110 South Dearborn St., Chicago 3, Ill.

NEW STANODIESEL OIL M

A new stationary industrial engine lubricant developed specifically to meet problems posed by new engine designs, higher loads, economy fuels

New STANODIESEL Oil M meets—and with plenty to spare—the performance requirements imposed on diesel lubricants by new engine designs, higher loads and the use of economy fuels. It meets these requirements because, first of all, it is an oil refined from the finest quality base stocks. It thus has superior stability. Then additives exclusive with STANODIESEL Oil M have been blended with these base stocks. The additives do these things:

1	**INHIBIT OXIDATION.** Prevent unwanted increases in oil viscosity. Prevent corrosion of bearings.
2	**PROVIDE DETERGENT-DISPERSANT ACTION.** Keep crankcase, pistons, cylinder walls and other parts clean. Keep contaminants in suspension, prevent redeposit.
3	**PROVIDE ANTI-FOAM ACTION.** Foaming tendencies of oil are controlled. Oil is suitable for use in hydraulic governors.
4	**INCREASE LUBRICITY.** Wetting agent increases oil's ability to reach and maintain a film on highly stressed parts.

STANODIESEL Oil M is a "Mil" type oil.

Your next move? Find out how STANODIESEL Oil M can serve you. In the Midwest call your nearby Standard Oil lubrication specialist. Or contact Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANODIESEL OIL M
Does these things for your engine

1. Lessens engine deposits, ring and cylinder wear.
2. Lessens spark plug fouling.
3. Lessens fuel injector and pump sticking resulting from engine deposits.

STANDARD

STANDARD OIL COMPANY (Indiana)

HERE'S WHAT THEY TELL US

A READER IN IOWA sent this urgent message

> We have an ex-Navy man at our plant who says the old-time Naval triple expansion reciprocating steam engines had no lubricators or mechanical oilers on them for internal cylinder lubrication . . . says they just brushed oil on the piston rods. I know this sounds like a foolish question, but can you tell us something about this practice?

Executive Editor Earle replied

> Your acquaintance at the plant is quite right. Many of those engines were operated without internal lubrication, primarily to prevent oil from getting into the exhaust steam and consequently into the condensers.
>
> Here's one very important point I have heard old marine engineers mention in regard to it. Practically all these engineers say that if a vertical steam engine has been started up and run without internal cylinder lubrication, everything is fine; but if afterwards, for some reason, you introduce cylinder lubrication, you never can go back to "dry" operation again. Just why this is so I have never been able to learn, but everybody who has had any experience says it is so.
>
> The fact remains that I have seen unlubricated cylinder walls in these engines that were just as smooth as satin and in perfect condition.
>
> All this applies only to vertical steam engines, and not to horizontal engines.
>
> Consult the engine manufacturer and see what he recommends.

E. B. PLAPP, Chief Engineer for American Smelting and Refining Company, El Paso, Tex., obviously has been delving into old issues of POWER ENGINEERING. He said

> I should like to obtain a copy of an article published in the January, February and March 1943 issues of *Power Plant Engineering** entitled — Dew Point of Flue Gases of Fuels Containing Sulphur, written by Yeaw and Schnidman.
>
> Will you kindly tell me where I may obtain copies of these issues of the magazine?

The series was published more than 10 years ago, so we were unable to furnish copies of the magazine. But it so happened that many other readers since that time had requested photostats of the article and we still had the negatives.

* Former name of POWER ENGINEERING

TO ROBERT M. ROSENDALE, System Planning Dept., Pennsylvania Power & Light Co., our executive editor wrote

> By a stroke of great good luck I was able to find in my own personal engineering file, the last two copies of the complete paper on Pumped Storage Hydroelectric Power, that we have in this office. Accordingly, here is one of them you requested in your letter.

We are keeping the last copy for our files but we may reprint it later if enough of our readers want it. The article, Pumped Storage Hydroelectric Power, was published in October 1951 as a 12-page reprint, with a 3-page digest of it in the October 1951 issue of POWER ENGINEERING.

STRANGE as it may seem, W. F. Hull, Research Department, Western Precipitation Corporation, remarked in a note to our editor

> I read a recent article of yours on atomic power concerning direct conversion to electric power. However, my reason for writing concerns your name. I knew an engineer by the same name when I worked in the Air Conditioning Department of the General Electric Company at Bloomfield, N. J. about 1938. I'm wondering if you are he.

Andrew Kramer answered

> No, I am not the same man. I never met that other Andrew W. Kramer, but I did have some correspondence with him, and still another electrical engineer by the same name. For a long time I failed to get my copies of the General Electric Review, and at one time also I failed to get my copies of Electrical Engineering. Upon inquiring, I found that these had been going to this other Andrew W. Kramer. I think at that time he was at the Fort Wayne Works of the General Electric Company and later on was transferred to Bloomfield.
>
> In any case it was rather an amusing situation where we had three Andrew W. Kramers all electrical engineers.

Now we are told there are four A. W. Kramers, all electrical engineers.

In 1942, A. W. Kramer, a radio engineer of Corpus Christi, Tex., placed an order with us for "two volumes published some years ago, entitled Electricity — What It Is and How It Acts by A. W. Kramer." He thought the books might have been written by his father who was an electrical engineer. But they were written by our editor who has also been a member of the I. R. E. and the A. R. R. L. for many years.

ALAN L. KING, Assistant Director, Safety and Loss Prevention Dept., American Cyanamid Co., commented

> The article on lightning by A. P. Broadhead appearing in the October '53 issue of POWER ENGINEERING was excellent and has been extremely valuable in our safety work.

ALAN B. BROWN, Safety Consultant, The Atlantic Refining Company, Philadelphia, wrote

> We are particularly interested in an article which appeared in the February '55 issue of POWER ENGINEERING, "Non-Sparking Tools Can Spark."
>
> With your permission we should like to make copies of this article for distribution to certain interested persons in our Refinery.

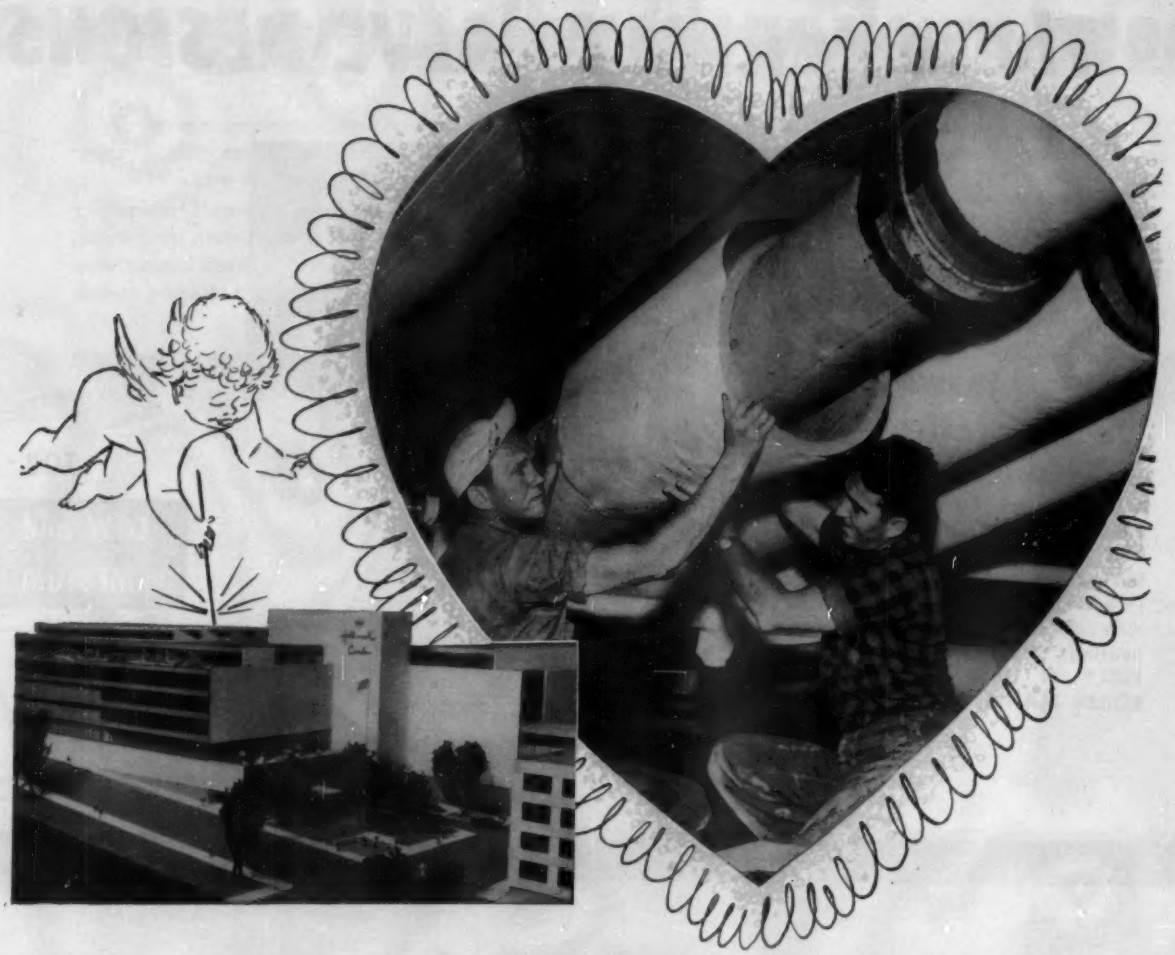
A later note said

> We made approximately one hundred copies of the article. They were distributed to many of our supervisors.

GENERAL MANAGER G. C. Stewart, National Safety Council, said

> It was most kind of you to go to the trouble to send me the copies of the bibliography of safety articles carried in POWER ENGINEERING. No wonder you won an award!
>
> I am sure you realize how grateful all of us are for what your magazine is doing for safety. It is very encouraging, and I am sure you have prevented many accidents through your continuing leadership in this field.

"Well, we girls don't think it's too hot in here. And if you turn up the air conditioning we'll all start wearing overalls."



Hallmark Cards cared enough to put on the very best . . .

GUSTIN gb BACON SNAP*ON

One of the Midwest's outstanding buildings is the new Hallmark Cards building in Kansas City, Missouri, home of the famous manufacturer of greeting cards for those "who care enough to send the very best".

Inside this enormous structure, 50,000 feet of hot and cold lines are insulated with G-B Snap*On pipe insulation—the new one-piece molded pipe insulation of fine glass fibers. Thermally, it is superior to any comparable product. It is also far lighter in weight, far easier to handle, far more economical to apply. One-piece sections are available plain or with muslin for heated piping, or with vapor barrier jackets adhered for chilled lines. As the photo indicates, they go on the pipe as quickly as you can say "Snap*On"—and they will do their job indefinitely because they are as permanent as glass itself.

Modern plants of every type throughout the country are selecting Snap*On for chilled lines or heated piping where temperatures do not exceed 350° F. You, too, can put on "the very best" and *save money in the bargain!* Write this very day for samples and complete technical literature.

GUSTIN-BACON *Manufacturing Company* GUSTIN gb BACON

Thermal and acoustical glass fiber insulations • Pipe coverings and fittings • Molded glass fiber pipe insulation

250 W. 10th STREET KANSAS CITY, MISSOURI

For more data circle 505 on Post Card

NEW STANODIESEL OIL M

A new stationary industrial engine lubricant developed specifically to meet problems posed by new engine designs, higher loads, economy fuels

New STANODIESEL Oil M meets—and with plenty to spare—the performance requirements imposed on diesel lubricants by new engine designs, higher loads and the use of economy fuels. It meets these requirements because, first of all, it is an oil refined from the finest quality base stocks. It thus has superior stability. Then additives exclusive with STANODIESEL Oil M have been blended with these base stocks. The additives do these things:

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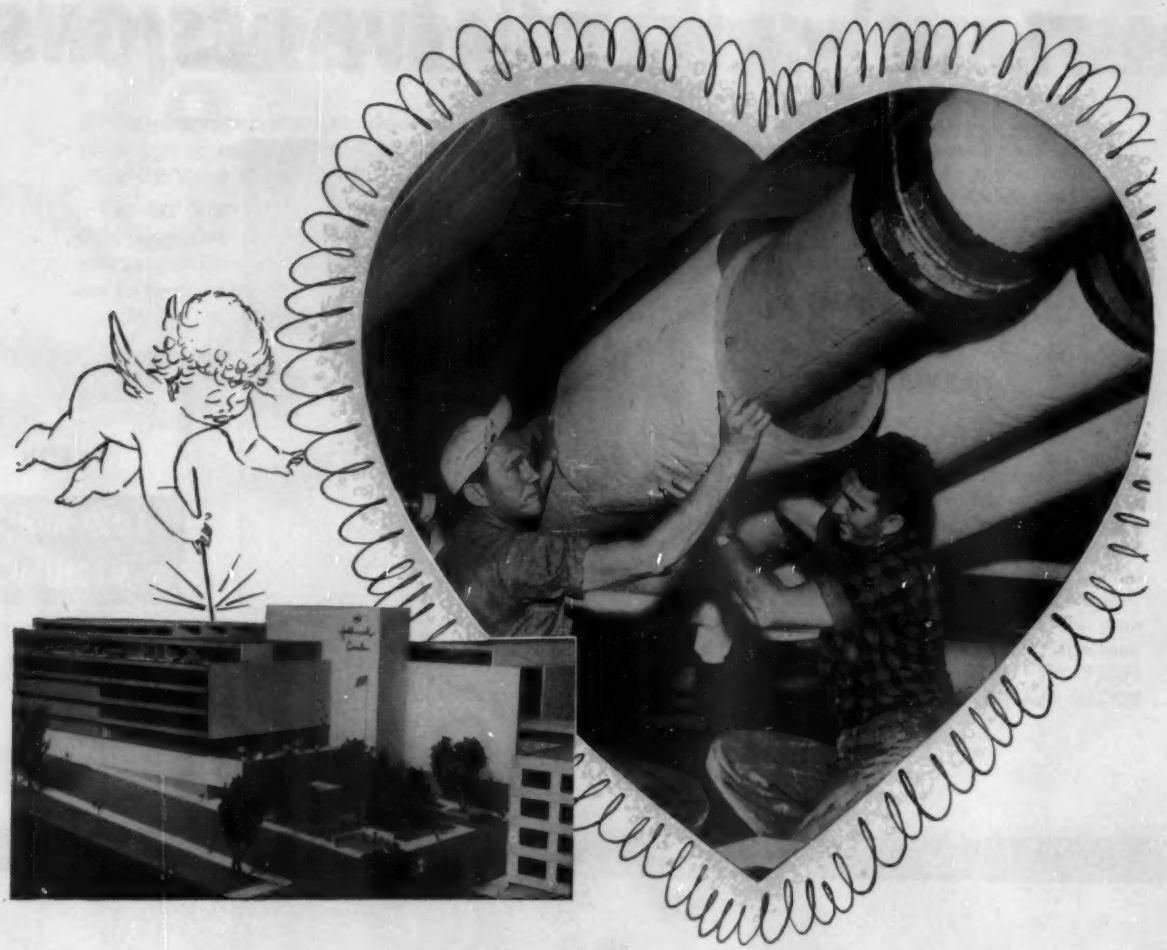
STANDARD OIL COMPANY (Indiana)



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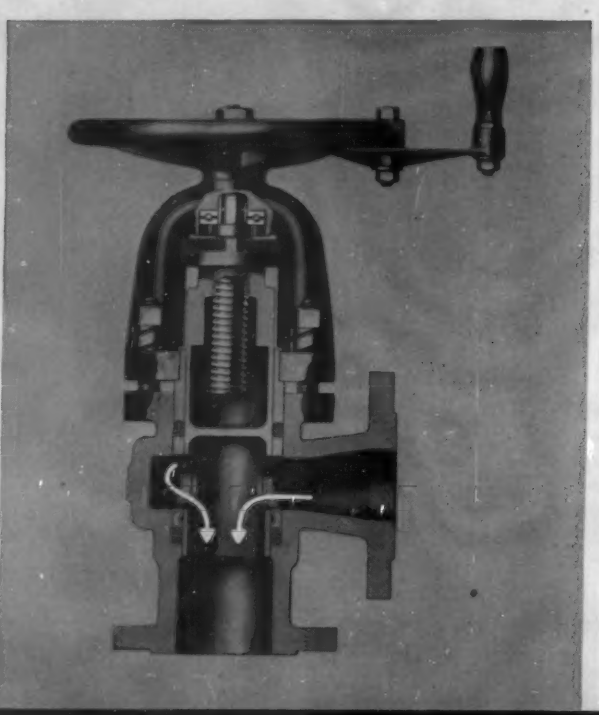
GUSTIN-BACON *Manufacturing Company* GUSTIN gb BACON

Thermal and acoustical glass fiber insulations • Pipe coverings and fittings • Molded glass fiber pipe insulation

250 W. 10th STREET KANSAS CITY, MISSOURI

For more data circle 505 on Post Card

These YARWAY VALVE DESIGNS



YARWAY SEATLESS

Features balanced nitralloy hollow plunger that seals line drop-tight, yet permits free, unobstructed flow in blow-down. Other features —laminated packing, alemite lubrication, ball thrust bearings. USED SUCCESSFULLY IN OVER 15,000 BOILER PLANTS.

FOR LOW and MEDIUM PRESSURES

YARWAY HARD-SEAT

Features tough, stellite-faced and ground disc and seat ring, mated to provide smooth long-wearing surfaces. Stream-line flow. Alemite lubrication. MORE THAN 4 OUT OF 5 HIGH PRESSURE BOILER PLANTS USE YARWAY BLOW-OFF VALVES.

FOR HIGHER PRESSURES

USED IN OVER 15,000 BOILER PLANTS

serve every boiler blow-down need

■Whatever your *pressure* requirement, whatever your *piping* requirement—there's a Yarway Blow-Off Valve to exactly meet your needs.

Popular Yarway *seatless* design keeps blow-down lines drop-tight in low and medium pressure ranges. Sturdy Yarway *stellite seat and disc* design protects higher pressures.

All Yarway Blow-Off Valves are strong, rugged valves, built to withstand the punishment of regular or emergency blowing-down under full boiler pressure, and are available in metals that stand up under acid washing of boilers.

Write for new Yarway Blow-Off Valve Bulletins—B-426 (pressures to 400 psi) or B-434 (pressures to 2500 psi).

● Yarway Type B Seatless Blow-Off Valve, iron body for boiler pressures to 200 psi, steel bodies, for pressures to 400 psi. Angle valve shown, straightway available. Flanged connections. See Bulletin B-426.

● Yarway Type B Seatless Tandem Blow-Off Valve combining two angle valves. Other combinations available. Iron bodies for boiler pressures to 200 psi, steel bodies for pressures to 400 psi. See Bulletin B-426.

● Yarway Type C Seatless Tandem Blow-Off Valve combining angle and straightway valves. Other combinations available. Flanged or welding connections available. For boiler pressures to 600 psi. NOTE: When used in tandem with a Yarway Hard-Seat Valve, Type C Seatless may be used to 1500 psi. See Bulletin B-434.

● Yarway Hard-Seat Blow-Off Valve for pressures to 2500 psi. Straightway valve shown. Angle available. Welded (shown) or flanged connections. See Bulletin B-434.

● Yarway Hard-Seat—Seatless Bolted Tandem Blow-Off Valve. Hard-Seat is the blowing valve, seatless is the sealing valve. Available in any combination of connections. For pressures to 1500 psi. Hard seat-hard seat tandems for pressures to 2500 psi. See Bulletin B-434.

● Yarway Unit Tandem Blow-Off Valve. Combines a hard-seat blowing valve and a seatless sealing valve in one-piece forged steel body for boiler pressures to 1500 psi. For pressures to 2500 psi, two hard-seat valves are combined. See Bulletin B-434.

LET YARWAY HELP SOLVE YOUR BOILER BLOW-DOWN PROBLEMS!

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY — **blow-off valves**

ERIE CITY

manufactures all major of their STEAM GENERATORS responsibility for

- BOILERS
- SUPERHEATERS
- AIR HEATERS
- STOKERS
- ERECTION
- SERVICE

Investigate the advantages obtained through the purchase of complete, modern, steam generators by Erie City Iron Works. No division of responsibility—one manufacturer builds all the component parts—each part designed and engineered for maximum efficiency—all erected and serviced by Erie City under one contract.

When fuel and boiler room labor costs affect your competitive position, when steam demands crowd old boilers to the dangerous limit, it is time to consider the advantages obtained by using steam generators designed and built by Erie City Iron Works. Bulletin SB-50 describes the complete line of power equipment.

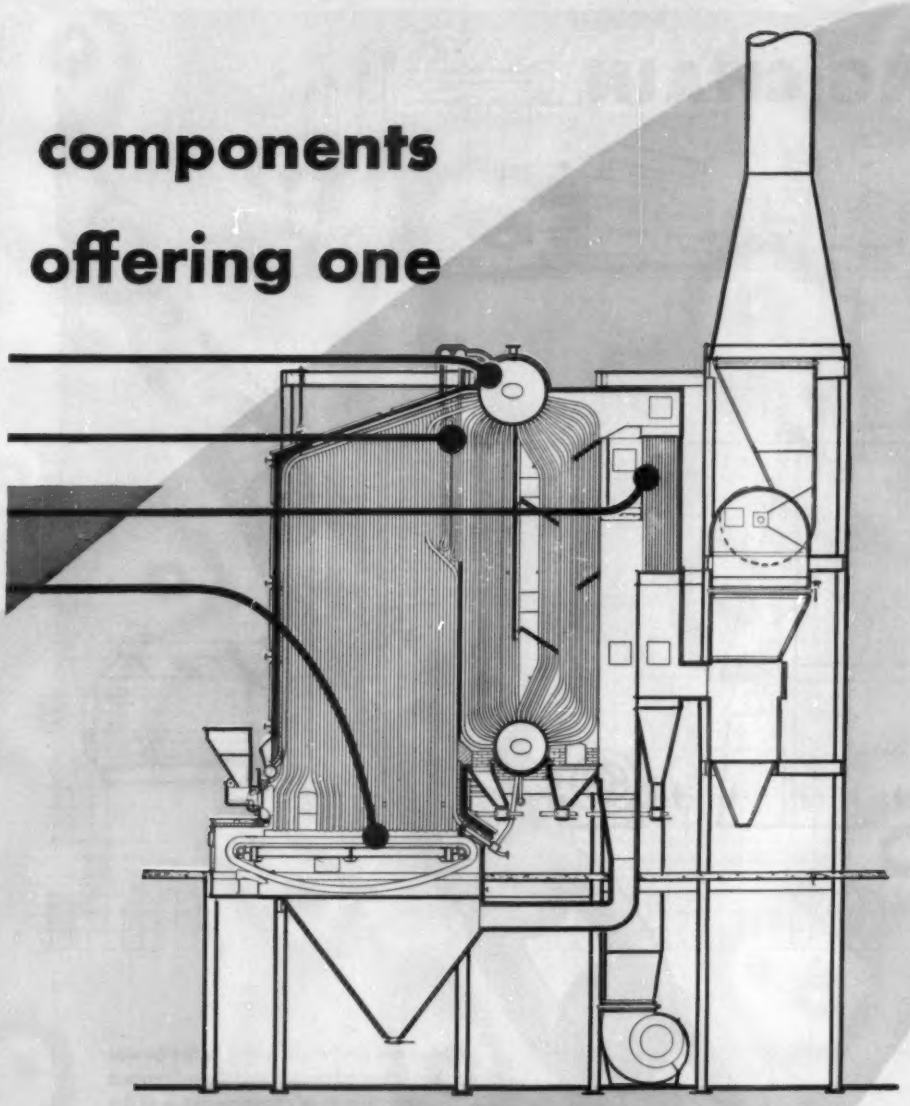
You can depend on Erie City for sound engineering

ERIE CITY
115 Years in Steam Generation

ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

components offering one



Three Steam Generators with

Erie City 100,000 lbs. per hour 2-Drum Boilers

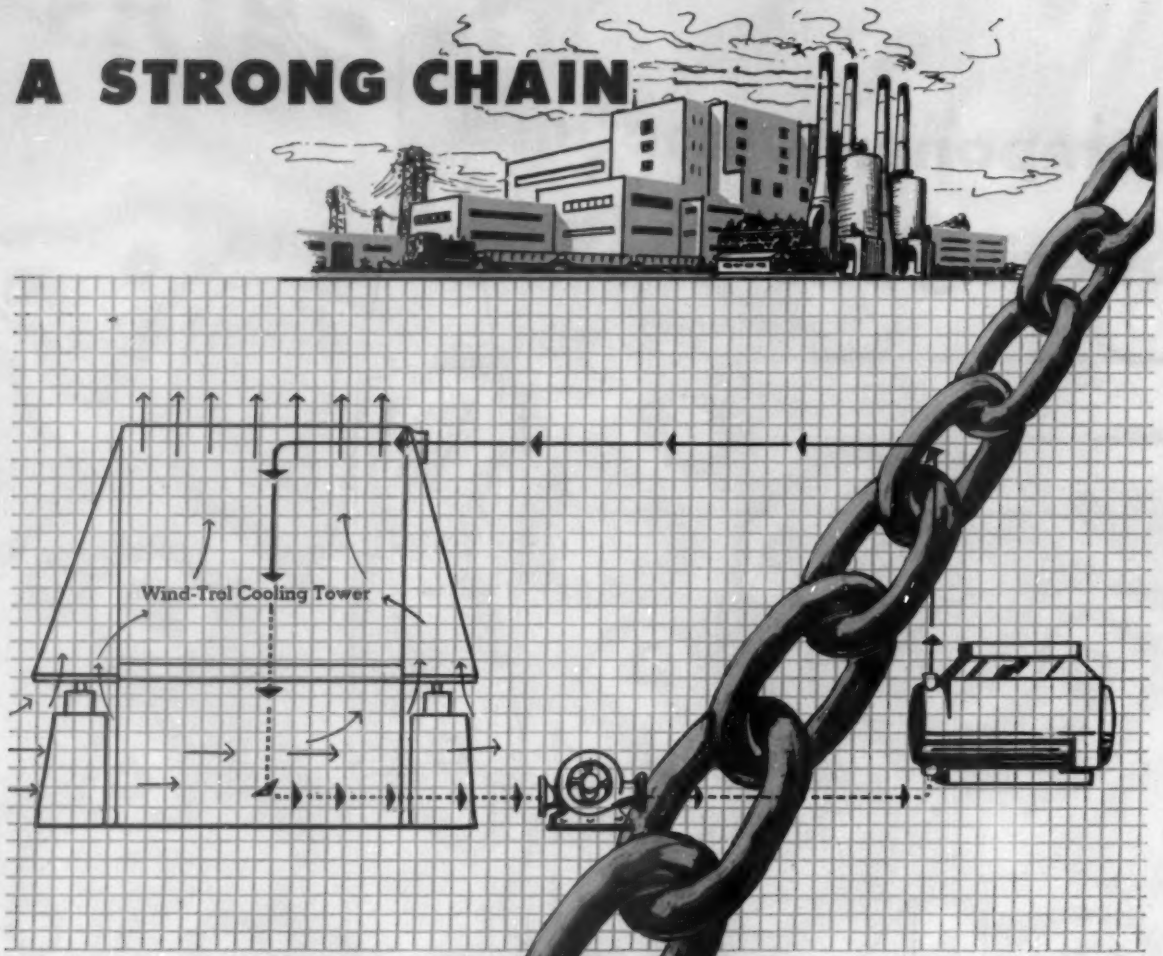
Erie City Single Pass Tubular Air Heaters

Erie City "Travagrate" Continuous Ash Discharge Spreader Stokers

Erie City Pendant Type Superheaters

For more data circle 507 on Post Card

A STRONG CHAIN



There are no "weak links" in the power plant that takes advantage of the advanced performance characteristics of the Santa Fe Wind-Trol Cooling Tower. The Wind-Trol is an improved design, either cross- or counter-flow, based on more effective application of proven principles. Because the Wind-Trol operates efficiently regardless of wind velocity or direction, is independent of environmental influences and nullifies recirculation, it permits the incorporation of a "safety factor"—previously unobtainable in a power plant cooling tower, but found in all other equipment in the system.

Write for Bulletin No. PE-R-355

SANTA FE SINCE 1903 TANK & TOWER CO. INC.

"Our best ads are installed."

SANTA FE TANK & TOWER CO., INC.

5401 South Boyle Avenue • Los Angeles 58, California

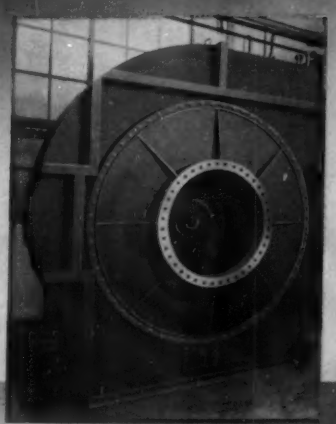
BRANCHES IN ALL PRINCIPAL CITIES

For more data circle 508 on Post Card

GREEN
POWER AND PROCESS PLANT EQUIPMENT

AIRFOIL TYPE DRAFT FAN

M *ost*
E *fficient*
P *oint* of Six Designs ranges from 80-84 static efficiency



Those of you who have known GREEN for many years know that our ratings have always been conservative. You won't get less; often you get more.

With our *modernized* line of AIRFOIL Type Fans — we're calling them the GALEX Fans—we are following the same policy. Results—both test and operating—indicate our GALEX Fans will produce consistently high efficiencies. Static efficiencies are noted above. Mechanical efficiencies range from 84-88%. But with so many variables both in fan design and in operating conditions, buyers prefer the conservative ratings.

To this line of modernized, streamlined draft fans of the AIRFOIL Type, Green engineers bring more than 48 years of experience in designing and manufacturing draft fans. Actually, this AIRFOIL Type of Fan is nothing new to us. We made them in this country during the World War I era and many of those old AIRFOIL Type Fans are still in service. Today, some 35 years later, much more is known about fans and their behavior. Today, Green Fans are in an even stronger position to meet the requirements of the modern power plant.

We'll be glad to discuss your fan requirements with you and see which of the six AIRFOIL Designs would be best. With six designs, many combinations of volume and pressure are available.

GREEN THE AIRFOIL TYPE FAN Galex FAN

GREEN FUEL ECONOMIZER COMPANY, Inc.

BEACON 3, NEW YORK

For more data circle 509 on Post Card

"WE CUT MOTOR REPAIRS FOR ONE OF OUR CUSTOMERS FROM 18 MOTORS PER YEAR TO 2 BY INSTALLING FUSETRON FUSES"

"The owner of a large poultry farm is one of our customers. In his operation a great number of motors are used in many different ways — pumps, feed grinders, heating systems, ventilators, etc.

"But these motors were giving him so much trouble that we were rewinding from 12 to 24 burned out motors a year for him.

"To correct the trouble, we suggested protecting the motors with Fusetron dual-element fuses. He told us to go ahead and try them. So, after checking the circuits and motors, Fusetron fuses were installed in proper sizes.

"Fusetron dual-element fuses proved themselves from the beginning. For the entire year following their application, only 2 motors were repaired and this trouble was caused by over lubrication.

"The motors we rewind are guaranteed for a year so we want to be sure they are properly protected. That's why we recommend to all our customers that they use Fusetron dual-element fuses."

Lawson E. Cobb
President
NEW ENGLAND ELECTRIC
MOTOR EXCHANGE INC.
GARDNER, MASS.

ROBERT E. HENRIKSON
Shop Foreman

FUSETRON is a trademark of Bussmann Mfg. Co.

Harlan F. Cobb
Vice President

FUSETRON dual-element FUSES do more than cut your motor repair costs

Fusetron fuses save you recalibration and maintenance costs

Fusetron fuses are *calibrated at the factory by engineers.* Once properly installed, they require no periodic inspection or down-time necessary on mechanically operated devices.

Fusetron fuses eliminate down-periods caused by needless blows

Fusetron fuses can increase production and reduce annoying interruptions of regular maintenance because — they wipe out needless blows caused by harmless overloads or excessive heating.

Fusetron fuses increase life of equipment

If there is an electrical fault, Fusetron fuses open and warn of danger and help hold fault to its source.

Panels and switches are protected against damage due to poor contact heating.

100,000 amp., interrupting rating gives you maximum safety

Fusetron fuses can safely interrupt the most severe available short circuit current — and are adequately safe to meet future circuit growth.

Fusetron fuses save on installation costs

They protect against waste of space and money by permitting use of proper size panels and switches, instead of oversize.

Here's why Fusetron fuses give all-purpose protection

A fuse link combined with a thermal cutout — the result, a fuse with tremendous time-lag and much less electrical resistance and an interrupting rating in excess of 100,000 amps.

They have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to same dimensions as ordinary fuses. FUSETRON Fuses fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.

Write for bulletin FIS.

For loads above 600 and up to 5,000 amps., Use BUSS Hi-Cap Fuses . . .

They have unlimited interrupting capacity to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

Write for bulletin HCS.

BUSSMANN MFG. CO. Div. of McGraw Electric Co.
University at Jefferson, St. Louis 7, Mo.

Play Safe! install FUSETRON dual-element Fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!

FUSETRON — TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION — BUSS

708

For more data circle 510 on Post Card

"Maintenance needs Megger Testers
. . . as Surgery needs the X-ray"
"Megger"
INSULATION
TESTERS
"MEGGER"
MEGGER
Electrical Resistance Test
MANUAL
for
Megger
Insulation Testers
JAMES G. BIDDLE CO.

Biddle*

*Megger**

*

The word "MEGGER" is a registered trademark. There is only ONE "MEGGER" family of electrical resistance measuring instruments . . . and in the U.S.A., the words "BIDDLE" and "MEGGER" have been synonymous with electrical resistance testing since the beginning of the century.

INSULATION RESISTANCE TESTERS

Standard the World Over

One of the outstanding merits of all types of Megger instruments is quality of a high order. The performance and endurance records which these instruments have achieved are difficult, if not impossible, to match in any type of portable testing device. For insulation resistance measurements, Megger instruments are *the recognized standard.*

AN INTEGRAL PART OF ELECTRICAL OPERATIONS EVERYWHERE

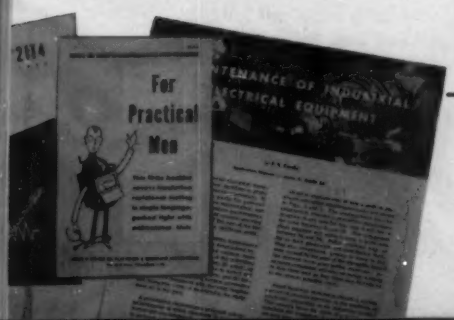
Throughout industry Megger Instruments have earned the distinction of being the most widely accepted devices for making electrical resistance measurements. They are the universally accepted instruments for preventive maintenance programs and the regular maintenance of electrical equipment. By their periodic use, and from the records of their measurements of the insulation in all important equipment, trouble may be anticipated and avoided, and production stoppages and losses reduced.

BIDDLE PRACTICAL TECHNICAL ASSISTANCE HELPS MAKE PRODUCTIVE MAINTENANCE POSSIBLE

Over forty years of experience in the field of electrical testing is represented in the manuals, bulletins, and other technical literature published by the Biddle Company. These are some of the extras you get with your purchase of a Megger Instrument. Practical engineering assistance is always available without obligation.

Want Practical Help?

A complete file has been prepared for your reference in setting up and interpreting a practical electrical testing program. Included is the 100-page Megger Insulation Testing Manual . . . a valuable addition to any electrical man's library. Check the coupon or write for File 21–PE



James G. Biddle Co.

Established 1895

Electrical & Scientific Instruments

1316 Arch Street, Philadelphia 7, Pa.

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Name_____ Title_____

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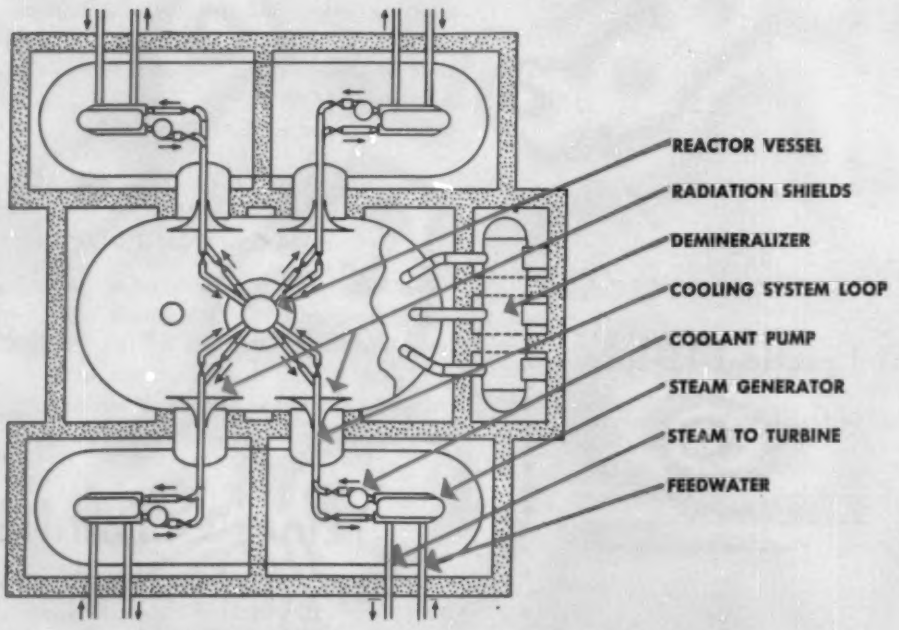
Address_____

City_____ Zone_____ State_____

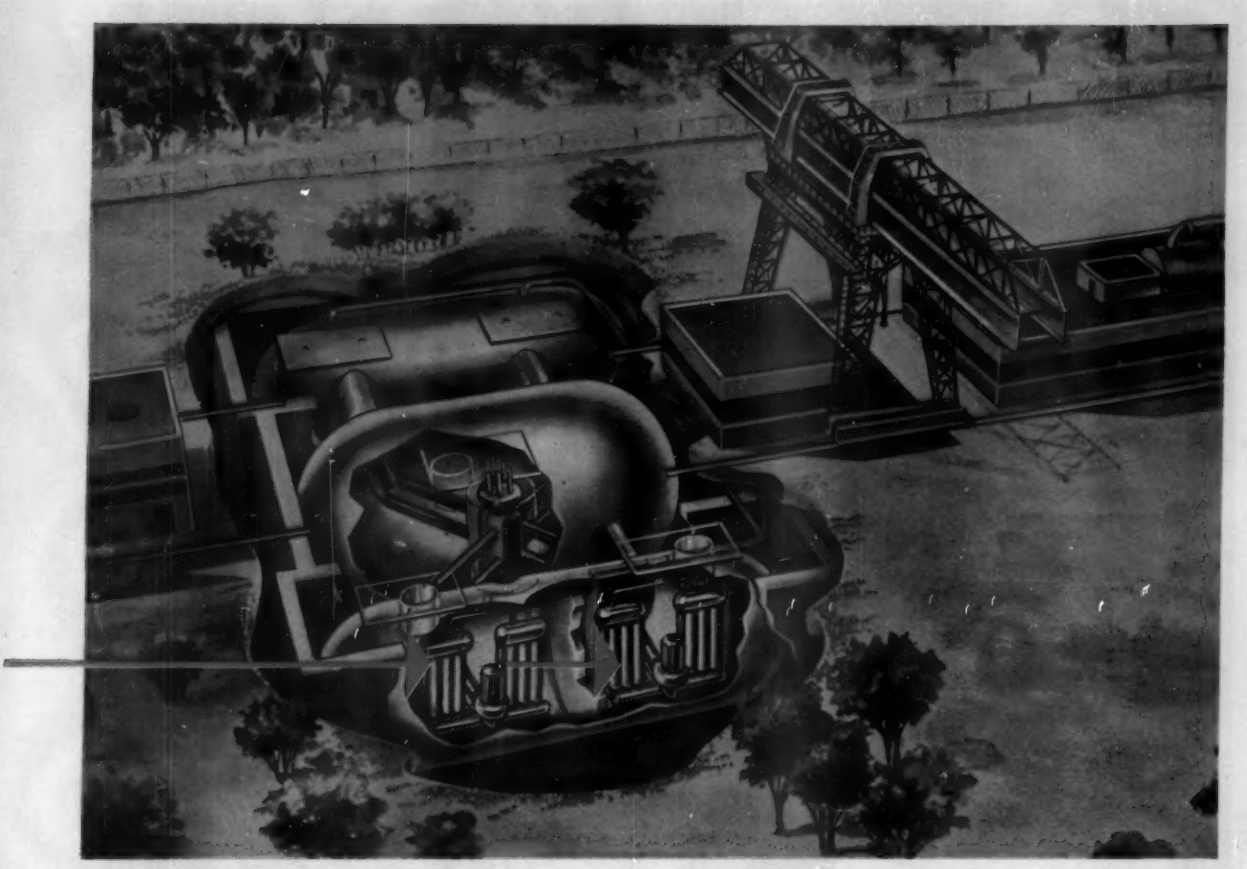
in nation's first full-scale

Atomic Power Plant

Foster Wheeler steam generators will help convert nuclear energy into kilowatts



Schematic plan view of nuclear reactor and steam generator sections of the Duquesne Light Company's atomic power station, now under construction at Shippingport, Pa.



Pressurized water reactor power station at Shippingport marks historic milestone in the generation of electric power

THE atomic power plant of the future is a dream no longer. Ground has been broken and construction is now under way!

Here at Shippingport, Pa., the Atomic Energy Commission and the Duquesne Light Company are cooperating in a joint project, erecting the nation's first full-scale atomic power generating station. This nuclear power plant will make an historic contribution to the entire electrical industry.

The nuclear reactor portion of the plant which is being built for the AEC by Westinghouse Electric Corporation will be located underground in huge, shielded steel shells as shown in the artist's sketch above. The steam generators (heat exchangers) will convert heat from the reactor to 600 psia steam for driving the turbo-generator.

In designing and building two of the four steam generators for this first commercial atomic power plant, Foster Wheeler will bring to bear a wealth of practical experience in the nuclear power field. Since the administration of the Manhattan District, wartime predecessor of the AEC, Foster Wheeler has been actively engaged in atomic energy work. FW nuclear power heat exchangers are installed at the National Reactor Testing Station, the Knolls Atomic Power Laboratory, and on board the U.SS. "Nautilus"—first atomic power submarine.

In conventional or atomic power plants, heat engineering by Foster Wheeler means efficient and dependable steam generation at low overall cost. For the latest Nuclear Forecast and information on a low-cost Nuclear Power Plant, write for HE-5-55. *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

FOSTER WHEELER

LONDON • NEW YORK • PARIS • ST. CATHARINES, ONT.

For more data circle 512 on Post Card

Painting, courtesy Power Magazine

New J-M Color Code identifies metal in Spirotallic® Gaskets

Most engineers know that Spirotallic Gaskets maintain a perfect seal despite extreme fluctuation in fluid pressure and flange compression. Consequently, these gaskets are used in a wide range of service conditions which include high temperatures, elevated pressures and active corrosives. To withstand these conditions, Spirotallic Gaskets employ a variety of corrosion-resistant alloys.

Because so many of these metals look alike, only expensive tests or costly experience with the gasket could determine the gasket metal used, once its identifying tag was lost. Now the color patch on the centering guide tells the metal employed and saves time, trouble and expense. This new method of identification also makes it easier for storekeepers and mechanics who handle the gasket. In addition, it simplifies inventories.

Spirotallic Gaskets hold their seal because they are made of spirally wound interlocking plies of asbestos and spring-like metal strip. These gaskets compress easily with light bolting. For catalog PK-35A and copy of color code card write Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ont.

Here are seven of the metals available and their color identifications

Zinc-coated steel—white

Type 304 Stainless—yellow

Type 316 Stainless—green

Type 347 Stainless—blue

Monel—orange

Copper—brown

Aluminum—aluminum

JM PRODUCTS

Johns-Manville SPIROTALLIC GASKETS

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POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

POWELL VALVES THE COMPLETE QUALITY LINE

FIG. 1503—W.E. 150-Pound Cast Steel Gate Valve

FIG. 19084—900-Pound Pressure Seal Non-Return Globe Valve, Gear Operated

FIG. 3031—W.E. Cast Steel Globe Valve for 300 Pounds W.S.P.

FIG. 11365—Cast Steel Pressure Seal Horizontal Lift Check Valve for 1500 Pounds W.S.P.

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

Investigate the many outstanding features of the High Pressure Boiler Non-Return Valve shown above (Fig. 19084). And be sure to find out about the *complete* line of Powell Valves —*quality* valves that will give you dependable flow control.

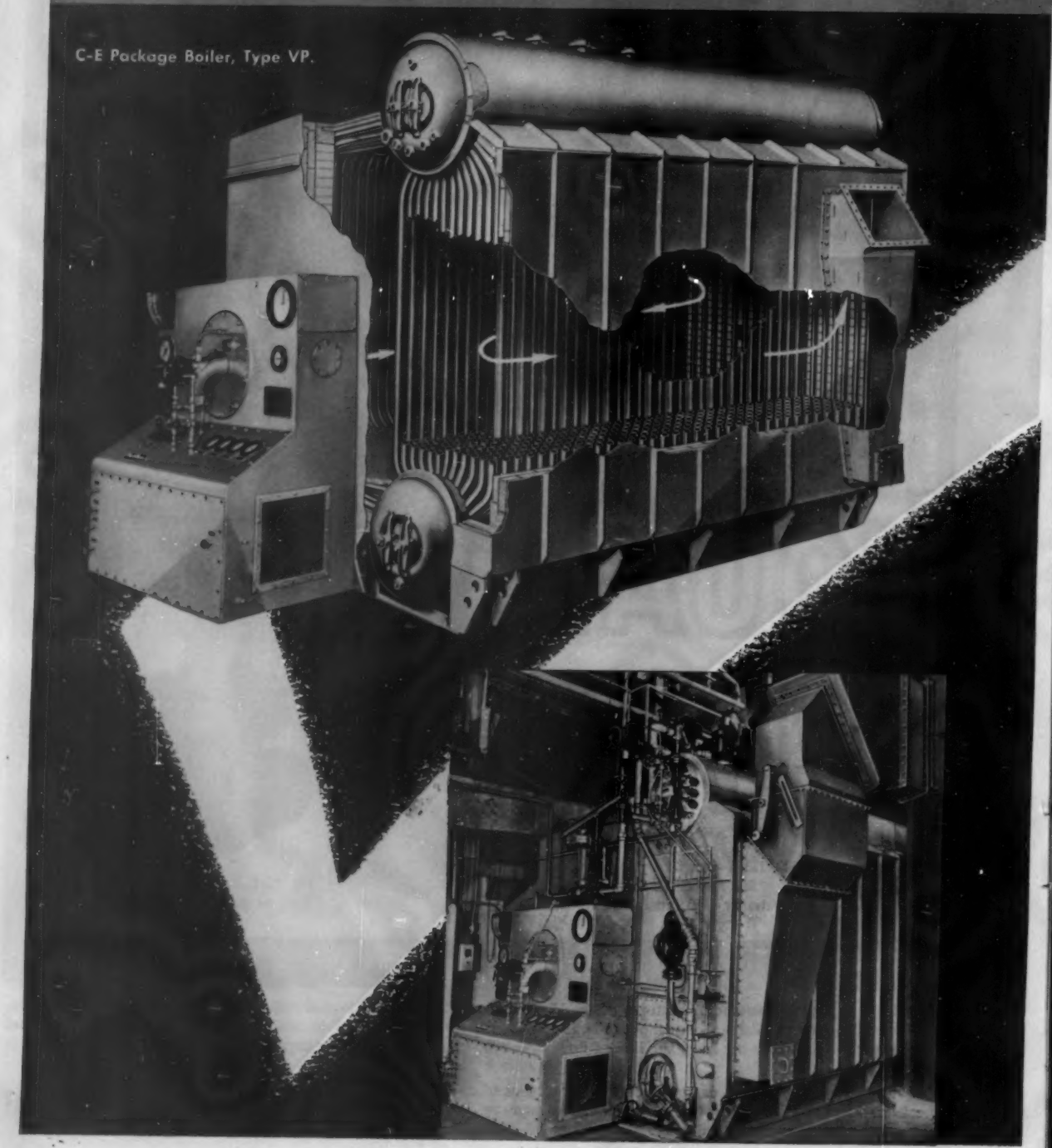
The valves shown above are examples of the many types of precision-built valves that carry the Powell name and measure up to the Powell standards of quality.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our complete line, and help solve any flow control problem you may have. Write . . .

The Wm. Powell Company, Cincinnati 22, Ohio . . . . . 109th year

For more data circle 514 on Post Card

BEFORE YOU BUY A PACKAGE BOILER . . .



C-E Package Boiler, Type VP.

CHECK THIS LIST!

	BOILER A		B		C	
	Yes	No	Yes	No	Yes	No
Will your boiler be a real "package" type with control panel and all controls mounted integral with the boiler?	☐	☐	☐	☐	☐	☐
Will your package boiler be equipped with drum internals to assure dry steam?	☐	☐	☐	☐	☐	☐
Will its "steam quality" be backed with a guarantee?	☐	☐	☐	☐	☐	☐
Will your boiler have a 30-in. lower drum to provide convenient accessibility?	☐	☐	☐	☐	☐	☐
Will yours be a one-burner boiler, with a simple wiring and control system?	☐	☐	☐	☐	☐	☐
Will your boiler have the largest load swing range available?	☐	☐	☐	☐	☐	☐
Will your boiler be equipped with a quiet centrifugal fan?	☐	☐	☐	☐	☐	☐
Will your furnace be *completely* water-cooled?	☐	☐	☐	☐	☐	☐
Will your furnace have the highest ratio of water cooled surface to furnace volume?	☐	☐	☐	☐	☐	☐

If you are in the market for a package boiler, this check list can provide you with some interesting answers. Of course C-E's Type VP Boiler rates a "yes" answer to every question. In addition it offers many other operational advantages such as simple, effective soot blowing; high heat absorption; low draft loss; no dead gas pockets and simple baffle arrangements.

Little wonder then that VP purchasers range from small companies to some of the largest in the country . . . industrials of all kinds . . . schools and institutions . . . various government agencies . . . including the Atomic Energy Commission. These users are employing VP Boilers for all types of applications — heating, process, and even power generation.

SPECIFICATIONS
of the VP Boiler

Capacity — 4,000 to 40,000 pounds of steam per hour

Pressures — up to 500 pounds per square inch

Fuel — oil or gas

Erection — completely shop-assembled

Foundation — simple concrete slab

Make sure that you have details of the VP at your fingertips when you are in the market for a boiler of moderate capacity. Ask for the new Catalog VP-118, which contains specifications and general information on dimensions, construction details and controls. B-845

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE

For more data circle 515 on Post Card

MUD DRUM
as opened
after one year
on line
with
THE *Nalco* SYSTEM

Unretouched photo of Nalco treated boiler at Georgia Institute of Technology, Atlanta, Georgia

● Calling this a mud drum serves only to identify its location . . . it is perfectly clean after a full year on line. The unretouched photo was taken immediately after the drum was opened. No wash-out was necessary. Not only is the drum free of scale and corrosion . . . Nalco sludge conditioning operated so effectively that even under the static, off-line draining condition, no sludge deposited in tubes or drums.

The Nalco System can get results like these, economically, in *your* plant—regardless of boiler size or pressure. Write or phone Nalco today for action on a complete water treatment program.

NATIONAL ALUMINATE CORPORATION
Telephone: POrtsmouth 7-7240
6224 West 66th Place • Chicago 38, Illinois
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THE *Nalco*® SYSTEM . . . Serving Industry through Practical Applied Science

For more data circle 516 on Post Card

HELPFUL BULLETINS

INSTRUMENTS AND CONTROLS

101 Industrial Controls — The 1955 edition of company's industrial controls catalog, 46-pp, covers electrically operated valves for gas, air, oil, water, steam, and other fluids in various applications. Included are such items as gas valves for boilers, a series of three and four-way pneumatic valves for machinery, air pressure regulators. Information on explosion-proof housings is given for all valves, and particular emphasis is placed on applications for each item. General Controls Co.

102 Meters, Pyrometers — Bulletin G-9, 8 pp, describes electrical indicating panel meters and pyrometers. Lists various types of clear plastic case panel mounting meters as well as black Bakelite case styles, and also shows some new ruggedized and sealed models. Includes ordering information. Assembly Products, Inc.

103 Propeller Type Meters — Twelve-pp Bulletin 380-K4A covers company's complete line of Propeloflo meters, a direct-reading, propeller type instrument for metering water and other liquids. Divided into major sections on specifications, types, accuracy curves, ranges, installation dimensions, and pressure loss chart, it also contains subheadings on the electrically and electro-mechanically-operated totalizer, indicator, and recorder. General information on description and operation is also included. Builders-Providence, Inc.

104 Cooling Control — Supplement 1 to Bulletin 700-A describes a new self-powered cooling control which holds temperature of cooling water in jackets or coils of compressors, oil coolers, condensers, and others, and costs less than $40. Shows typical hook-ups. Sarco Co., Inc.

105 Remote Feed Formulation — Eight-pp Bulletin 0155 describes a proportioning system that permits remote dialing and weighing of individual feed ingredients. Besides discussing operation, bulletin describes three different installations of varied formulating capacities. Contains photos and three drawings illustrating system's panels, scales, feeders, control dials, counting and recording units and complete installations. Richardson Scale Co.

106 Filter Plant Gages — Bulletin 1002, 22-pp, features filter plant gages for the measurement of effluent flow, loss of head, wash water, water elevation and per cent of filter bed expansion. Describes various meters and includes facts on operation, construction, general information, sizes and capacities, specifications and other pertinent data. Text is supplemented with photos, cut-away views, and diagrams. Simplex Valve & Meter Co.

VALVES, PIPING FITTINGS

107 Stainless Steel Valves — Catalog 55, 12-pp, offers technical data on stainless steel valves, featuring design, selection, maintenance and repair facts. (Printed to form part of a forthcoming catalog, this technical section is being offered separately.) Photos, engineering drawings, and cut-aways combine to make it a complete, yet condensed, discussion of stainless steel valves. Cooper Alloy Corp.

108 Plug Valves — This 12-pp catalog describes a non-lubricated, non-corrosive, non-seizing, low maintenance valve for handling a wide range of fluids — where full flow, quick-operating quarter turn, shut-off plug valves are required. Explains design and operating features of the valve, gives materials specifications according to fluids handled. Lists sizes for high and low pressure types, and details repair procedure. Graham Products, Div., Graham-Lemunyon, Inc.

109 Refrigeration Valves — Twenty-pp Condensed Refrigeration Catalog, Form W-3-S illustrates and describes company's entire line of valves, filters and driers. New products are shown, along with standard equipment in the line. Charts, selection data, capacity tables are included. A-P Controls Corp.

110 Solenoid Valves — This 6-pp bulletin (Sec. C, Form RS 141) describes company's solenoid valves for use with liquids, gases or refrigerants, for stop and start operations, mixing and blending, metering or measuring, controlling pressure differential, controlling pressure, temperature and flow. Information on proper selection is provided. A-P Controls Corp.

111 Packless Expansion Joints — Catalog EZ-55, 12-pp, covers flexible pipe connections used to solve vibration and expansion control problems in industrial and process piping. Describes pressure and temperature ranges of application, lists dimensions and specifications, as well as illustrating various types of special-purpose joints available. Selection factors and installation procedures are given. T. R. Finn & Co., Inc.

STEAM GENERATORS

112 Steam Generating Units — Design data on outdoor and indoor installations of modern high pressure, high capacity steam generating units is contained in this illustrated 12-pp catalog. It is complete with charts and tables on company's line of boilers and includes information on superheaters, economizers, air-heaters, steam temperature controls, and steam purifiers. Springfield Boiler Co.

113 Package Boilers — This 12-pp booklet on package steam generators, describes the formulas behind package steam generators, and illustrates how installation of a package steam generator can raise steam capacity in an existing boiler room without extensive structural changes. Shows power engineers how to make survey of their steam requirements. Cyclotherm Div., National-U. S. Radiator Corp.

PUMPS AND COMPRESSORS

114 Sanitary Pumps — Fourteen-pp Catalog Section F describes Sanitor pumps, rotary pumps for use in food and dairy industries. Presents a pump with mounting bracket and stub shaft, V-belt drive units, gear drive units, direct connected Straitline units, variable capacity units, belt drive units. Also describes a model, engineered to provide the utmost in sanitary construction, which incorporates a 1200 rpm motor and totally enclosed V-belt drive. Viking Pump Co.

115 On-the-Spot Air — Eight-pp Form 2302 features company's self-contained Spot-Air portable compressor. Deals with the many tools it will operate, with actual on-the-job illustrations pointing out added advantages of this light-weight unit on jobs where bigger compressors are not needed. Ingersoll-Rand Co.

116 Two-Stage Compressors — Bulletin 16B8244 describes company's line of two-stage sliding vane type compressors for shop air, gas handling, drilling, and other applications. In addition to a table of ratings for two-stage compressors, bulletin carries a table of outline dimensions. A sectional view shows component parts. Allis-Chalmers Mfg. Co.

117 Balanced Opposed Compressors — Engineering data on company's balanced opposed compressors, 3000 to 10,000 hp (top range in tandem arrangement) is contained in 36-pp Bulletin L-679-B1. Presents information on operation, drives, design features, running gear, lubrication, valve action, capacity control, coolers and accessories. A chart listing approximate dimensions is included, along with photos of compressor installations. Worthington Corp.

PACKINGS, SEALS

118 Teflon Products — Three new bulletins present this company's Teflon packings, gaskets, special parts and stock. Bulletin CP552 describes Chempro lines of Teflon ring packing, Teflon impregnated asbestos packing, V-type packing, and Teflon seal cage — for use with acids and strong chemicals. Bulletin CP553 covers Teflon jacketed gaskets, solid ring gaskets, expansion joints and special gaskets. Bulletin CP554 illustrates special parts. Chemical & Power Products, Inc.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the Reader Service Cards page 119. When ordering catalogs, allow time for us to relay your requests to the manufacturers—and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

119 Improved Oil Seals — This illustrated 28-pp manual covers the selection, application and installation of Clipper Oil seals. Descriptions cover the latest seal designs, including the new LPD and RPD, the extruded and moulded oil slingers and end face seals. Important points

are illustrated by close-up photos and detailed drawings. Essential data is in tabular form, and documental case histories are included. Johns-Manville.

MECHANICAL POWER TRANSMISSION

121 Fluid Drives — Bulletins 9419 and 9519 are an illustrated catalog and selection guide on company's new Type VS Class 2 Gyrol fluid drives. Catalog discusses advantages and applications of the drives, covering speed control, power savings, simplified installation etc. A sectional view shows construction and principle of operation. Dimensions for six sizes of drives are provided. Selection guide consists of tables indicating proper drive to use with motors from 7.5 to 800 hp. Separate tables cover variable and constant torque loads. American Blower Corp.

122 Improved Speed Reducers — Forty-pp Engineering Manual LP 3 covers design features and application of Line-O-Power straight-line and right-angle speed reducers. Flexibility of this line of drives is stressed. Detailed selection data is provided, including service factors and load characteristics to be considered. Ratings and dimensions are given. Also described and pictured are units supplied with base plate ready for motor, drives with built-in backstop and drive combined with motor. Several installations are pictured. Foote Bros. Gear and Machine Corp.

123 Adjustable Speed Drive — Eight-pp Bulletin GEA-6234 presents the general purpose, full-wave Thy-mo-trol adjustable speed drive, covering in detail its simplicity of operation and economy. Features several industrial applications and emphasizes the unit's printed control circuits. General Electric Co.

HEATERS, HEAT EXCHANGERS

125 Unit Heaters — Publication B-1720, 24 pp, introduces a line of propeller fan heaters suitable for both steam and hot water. Design and construction features of the heaters are explained and illustrated. Basic steam and hot water capacities are tabled and information on selection of steam and hot water units provided. Booklet also gives mounting suggestions and includes piping and wiring diagrams, dimensional details. The 24 sizes in this line of heaters range from 63 to 1395 sq ft EDR basic steam ratings. Warren Webster & Co.

126 U-Type Heat Exchangers — An expanded line of standard U-type heat exchangers is presented in two 12-pp catalogs. Form GN-1054 lists capacities for a wide range of applications for Type SU heat exchangers — units designed for heating a liquid with condensing steam and constructed for 150 psi working pressure. Form GC-1054, on Type WU heat exchangers, describes standard shell and tube units that use boiler water for heating. In addition to heating applications, these units may be used as condensate coolers. Bell & Gossett Co.

127 Heat Exchangers — Catalog 1155, 4 pp, on stainless steel heat exchangers, provides data on applying them for heating or cooling liquids and gases used in chemical, pharmaceutical, refining and allied processing industries. Styles, sizes, dimensions, weights and materials of construction are given. A cutaway view shows major design features. Young Radiator Co.

LUBRICATION

129 Bearing Lubrication — Bulletin 506 offers lubrication and maintenance data for ball and roller bearings. Helpful lists of "do's" and "don'ts" to prolong bearing life, and facts on storage and handling of lubricants are included. New York & New Jersey Lubricant Co.

130 Colloidal Dispersions — Forty-four colloidal and semi-colloidal dispersions for operational functions, maintenance, lubrication, machine design, and other industrial applications are listed in this revised booklet. Includes dispersions of graphite, molybdenum disulfide, mica, vermiculite, zinc oxide, and acetylene black. Carriers and diluents are given for each product, along with typical applications, physical data. Acheson Colloids Co.

ELECTRICAL

132 Vertical Motor — Twelve-pp Bulletin GEA-6280 introduces manufacturer's vertical Tri-Clad motor. Emphasizes reduced maintenance costs and simplified lubrication of the new motor which is of shielded hollow-shaft, high-thrust type ranging from 7½ to 500 hp. General Electric Co.

133 Dry-Type Transformers — Totally-enclosed dry-type transformers with NEMA Group 3 class insulation for indoor or outdoor applications are described in Bulletin 61 B 8222. Steps in the building of the transformers are portrayed in bulletin, advantages are pointed out, and specifications included. Allis-Chalmers Mfg. Co.

134 Repainting Transformers — Eight-pp Bulletin GET-677F discusses the problems involved in repainting transformers in the field, and presents pertinent facts on how to assure longer paint life. Discusses methods of applying paint, paint preparation, number of coats required, and repainting of subway transformers. General Electric Co.

135 Low Voltage Breakers — Six-pp Bulletin 18B8252 outlines advantages of low voltage air circuit breakers for motor loads, lighting loads, heaters, welders, and transformers. Features which provide for greater accuracy, safety and flexibility are illustrated. Thermal curves showing average time current curve for various adjustments and typical selective trip curves showing ability of circuit breakers to be coordinated with other protective equipment are included. Allis-Chalmers Mfg. Co.

136 Automatic Speed Control — Eight-pp Bulletin 1882, illustrated in full color, shows how an improved pneumatic control, called Varitrol, has been designed into this company's Varidrive motors to increase and/or improve output of product, cut waste, save time and manpower. Photos explain how use of the Varitrol provides stable automatic control which permits Varidrive's speed to be controlled by pressure, temperature, humidity, flow rate, liquid level, others. Typical control applications are shown. U. S. Electrical Motors Inc.

137 Small Motor Switches — This 14-pp booklet describes a line of toggle, rotary and pushbutton switches — popular types designed to meet requirements of manufacturing and plant maintenance. Generously illustrated, this booklet also includes ratings. Cutler-Hammer, Inc.

138 Current-Limiting Fuses — Bulletin GEA-6319, 8-pp, features current-limiting fuses rated 250 and 600-v in sizes from 6 to 200-amp for low-voltage circuit applications such as fused safety switches, fused combination starters, small motor circuits, where conventional fuses do not have adequate interrupting capacity. Includes specifications, curves of current-limiting characteristics, tables of maximum rating for conductors, melting times, minimum back-up. General Electric Co.

139 High-Voltage Control — This company's Limitamp high-voltage motor control is the subject of Bulletin GEA-6331, 12 pp. Outlines in detail the features of the high-voltage, current-limiting, fused starters for coordinated control of squirrel-cage, synchronous, wound-rotor, and multispeed motors. Simplified installation and reduced space requirements are emphasized. General Electric Co.

140 Twist Prong Capacitors — Form UPX-155 is an 18-pp twist prong capacitor cross-index and price list of recommended replacements for several leading brands. Over 1000 different twist prong capacitor types are listed for quick interchangeability, along with the stock numbers and price of company's equivalent. Cornell-Dubilier Electric Corp.

141 Liquid Rheostat — Bulletin 14B8231, 8-pp, describes design features of company's liquid rheostat (Type 257) employing a complete NEMA 1 enclosure and other improvements. Points out advantages, discusses principle of operation and applications. Approximate weights and dimensions listed. Allis-Chalmers Mfg. Co.

142 High-Power Batteries — Bulletin CP-538/55 covers company's line of Hi-Power batteries for use in the control, switchgear, emergency lighting and auxiliary power fields. Includes data on battery ratings and capacities, details of design and construction, dimensions, weights and types of containers. C & D Batteries, Inc.

143 Improved Insulation — Twelve-pp Booklet B-6506 explains various advantages of Thermalastic insulation, designed to extend life of generators, sychronous condensers, frequency changers, large motors and other heavy rotating equipment in hard service. Contains a short, illustrative story on development of the insulation, describes properties, and includes application photos. Westinghouse Electric Corp.

144 Protective Material — This 12-pp brochure describes various usages of Safe-T-Seal, a chemical compound which impregnates any standard electrical insulation, fortifying it against premature disintegration due to humidity, moisture, extreme temperature changes or any other external factors which normally shorten motor life. Safe-T-Seal Div., MB Aircraft Services.

COMMUNICATION

146 Tone Signaling Units — Operating features and performance of company's supervisory tone equipment of modular design are presented in this 6-pp bulletin. Tells how these units transmit and receive signaling, dialing, telemetering, supervisory controls and other information, over wire lines, telephone or power line carrier, as well as over radio microwave communication circuit. Hammarlung Mfg. Co., Inc.

CONDENSER VACUUM INCREASED 1.7 INCHES IN 13 HOURS

DOWELL chemical cleaning boosted heat transfer efficiency 25 per cent

An iron oxide scale $\frac{1}{16}$ of an inch thick had seriously cut the efficiency of a surface condenser in this company's power plant. When the operator decided it was necessary to remove the deposits *fast*, he called Dowell.

Dowell engineers took especially prepared solvents to the plant in truck-mounted tanks. They applied the chemicals through regular connections using Dowell-designed equipment, which includes all necessary pumps and control devices. Both the steam and water sides of the condenser were cleaned in just 13 hours.

As a result of Dowell Service, the condenser's heat-transfer efficiency was increased 25%; vacuum was boosted from 25.90 inches to 27.60 inches. The operator reported that the increased operating efficiency of the condenser paid for the chemical cleaning within 10 days.

Dowell holds dismantling of equipment to a minimum on every job. The liquid solvents used can go wherever steam or water will flow, reaching places inaccessible to other cleaning methods. Dowell's experience, especially designed equipment and job-tailored solvents are designed to restore maximum efficiency to your equipment—fast!

For full information and estimates on cleaning *your* production facilities, call the nearest Dowell office. Or write Dowell Incorporated, Dept. H-24, Tulsa 1, Oklahoma.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

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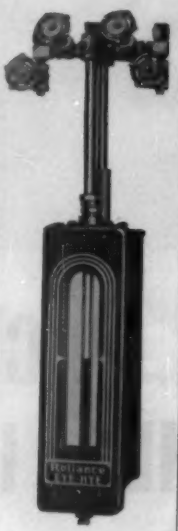
The Reliance Safety Team

Warns you of low or high boiler water

Prevents many a water level accident

SOUND CHECK ✓ ALARM Water Column

SIGHT CHECK ✓ EYE-HYE Remote Gage



It takes *Team Work* to prevent boiler accidents. No amount of *equipment* entirely offsets factors such as ignorance, carelessness and indifference on the part of operators.

It takes team work between men and devices to keep your plant safe. If your men can *hear* and *see*, their attention to the water level information supplied by the Reliance Safety Team will prevent boiler water level accidents.

The sensitive float-operated Alarm on the Reliance Water Column sounds a last-resort warning when water approaches low or high danger points. But for minute-to-minute scanning by operators, EYE-HYE beams its bright picture of true water level condition from its convenient eye-level position.

Avoid time-and-money-expensive low water accidents with the help of the Reliance Safety Team. Ask your nearest Reliance Representative, or write to the factory.

THE RELIANCE GAUGE COLUMN COMPANY
5902 Carnegie Avenue • Cleveland 3, Ohio

The name that introduced safety water columns....in 1884

Reliance®

BOILER SAFETY DEVICES

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147 Microwave Units — Microwave building block units which can be assembled in various combinations to provide numerous communications functions are described in five catalog sheets (C.5461 to C.5465). They include a transmitter, receiver-modulator, terminal AFC, baseband unit, and power supply. Each unit is described in detail and specifications provided. Radio Corp. of America.

WATER CONDITIONING

149 On Water Clarifiers — Technical Reprint T-135 is an illustrated 8-pp paper on water clarifiers, and cold process softeners. Discusses operating factors affecting dependability and economy of this equipment. Covers historical background of solids contact units, principles of seeding in chemical reactions, separation of precipitated solids. Sections are devoted to operating results, ability to handle surges. Graver Water Conditioning Co.

150 Diatomite Filtration — Twelve-pp Bulletin FA-51A covers filtration of potable water, process water and plant wastes with Celite diatomite filter aids. Explains how diatomite filter aids remove colloids and other suspended impurities; shows adaptability of Celite powders to various types of filter designs; and cites representative installations where it is being used. Johns-Manville.

You'll save time in ordering bulletins by using the Reader Service Cards on page 119. Of course we honor letterhead requests—but it takes us somewhat longer to handle them.

151 Diatomite Water Filters — Complete description of standard sizes of water filters, for use with porous stainless steel filter elements to handle 8 gpm to 939 gpm is contained in Release 214. Typical flow sheet is included, as well as full specifications. Micro Metallic Corp.

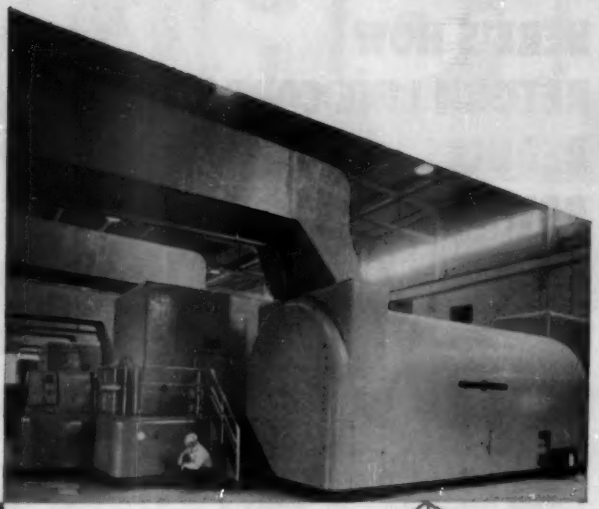
152 Keeping Equipment Clean — Suggested policies to follow in keeping water-using equipment clean are discussed in this 6-pp folder. Mentions trouble spots that can cause failures and enforced shutdowns. Cites several examples in which special problems were solved through proper cleaning program. Hall Laboratories, Inc.

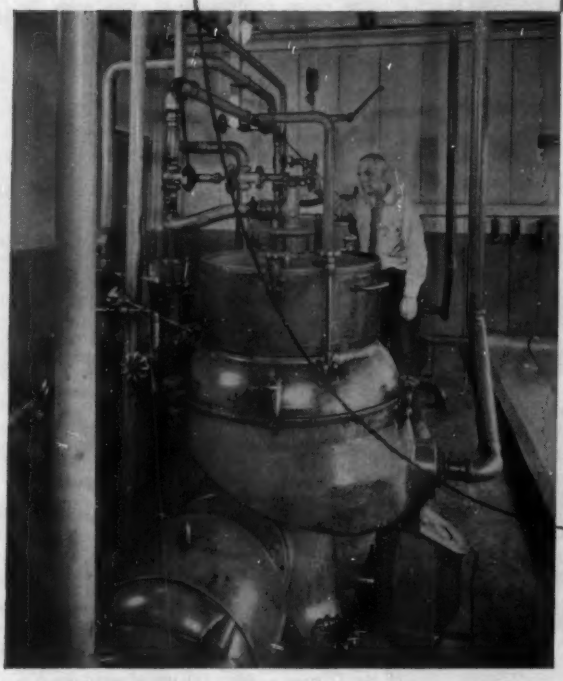
153 Silica Activator — Bulletin 63-11 describes company's silica activator used in the continuous preparation and feeding of activated silica, a coagulant aid in water purification and waste treatment processes. Contains photos and dimension drawings in addition to information sections on operation and description of unit. Omega Machine Co.

VIBRATORY EQUIPMENT

155 Electric Vibrators — Eight-pp Catalog 11 describes electric vibrators and gives specifications and prices. Covers silent, eccentric weight vibrators, electromagnetic vibrators, vibrating tables, and pneumatic vibrators. Furnishes graphic illustrations of vibrators in action, as well as information on installation of the units. Cleveland Vibrator Co.

15,000 kw. Gas Turbine Plant SAVES over $60.00 on Fuel per Hour of Operation!





The Rutland Plant of the Central Vermont Public Service Corporation has three 5000 kw. gas turbines . . . designed to burn low cost #6 Residual fuel oil.

BUT . . . ash deposit from the #6 fuel fouled turbine blading and nozzle ports . . . caused shutdowns . . . threatened to destroy parts of turbine by corrosion. Temporarily, the plant changed to costlier #2 distillate fuel.

Then technicians from the turbine manufacturer and from De Laval got on the job. It took work and engineering know-how to lick the problem. Solution? . . . a system of washing out the sodium and inhibiting the vanadium with *De Laval "Nozzle-Matic"* Continuous Discharge Self-Cleaning Heavy Fuel Oil Purifiers* capable of handling 45,000 gallons a day!

Mr. Norton M. Cobb, Plant Superintendent says: "To illustrate what the De Laval Centrifugal Washing System has done for us, let's take a look at the possible savings for oil alone . . . $60.00 per hour when all three units are on the line . . . this makes the original cost of the equipment seem incidental . . . After burning more than 3,000,000 gallons of washed fuel, we have noticed no appreciable loss of power due to ash build-up and no visible signs of corrosion. We are well satisfied with our washing installation."

A complete report on the "Rutland Case" is available. Write for it.

*Trade mark reg.

DE LAVAL

heavy fuel oil purifiers

THE DE LAVAL SEPARATOR COMPANY Poughkeepsie, New York • 427 Randolph St., Chicago 6 • DE LAVAL PACIFIC CO. 61 Beale St., San Francisco 5

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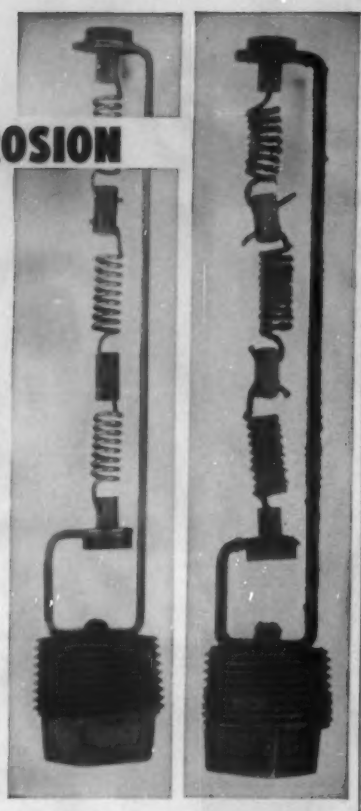
HERE'S HOW RETURN LINE CORROSION REDUCES POWER PLANT EFFICIENCY...



Return line corrosion is one of the most critical problems in maintaining economical, efficient power plant operation. To demonstrate what corrosion can do in steam and condensate return lines, we show here "before" and "after" unretouched photographs of N.D.H.A. Corrosion Testers. This is a test* developed by the American Society for Testing Materials in cooperation with the National District Heating Association. Bird-Archer supplies and analyzes these testers. Photo at left shows a Tester before installation. Photo at right shows a Tester after it had been installed for 60 days in the return line. (*Standard Method of Corrosivity Test of Industrial Water, NDHA Method, ASTM Designation 935-49).

HERE'S HOW YOU CAN ELIMINATE THIS WASTE WITH AMINE TREATMENT

Bird-Archer Amine Treatment is an easy, effective and economical way to eliminate corrosion troubles. Amines raise the pH value of the return condensate to the point whereby the corrosion potential is negative. In addition, amines provide a surface protection for the metal itself which further inhibits corrosion. In scores of plants, Bird-Archer Amine Treatment is paying a profit on its cost through savings in piping replacement and maintenance work.

WRITE FOR
BULLETIN CP-100
AND THE NAME OF THE BIRD-ARCHER SERVICE ENGINEER NEAREST YOU.

LABORATORIES · ENGINEERS · CHEMISTS

BIRD-ARCHER
WATER TREATMENT

THE BIRD-ARCHER COMPANY, 4337 N. AMERICAN ST., PHILADELPHIA 40, PA.
NEW YORK • CHICAGO
IN CANADA: The Bird-Archer Co., Limited, Cobourg, Ontario
BIRD-ARCHER COMPANY OF CALIFORNIA, San Francisco

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156 Vibratory Equipment — Pocket-size Condensed Catalog 554 contains 50 pp of technical data, descriptive text and photos of vibratory equipment, feeders, conveyors, power tools, shaft seals, other materials handling equipment. Syntron Co.

OTHER EQUIPMENT

157 Improved Machine Mountings — Bulletin K4A gives engineering specifications and performance data on vibration, shock and noise control products. Presents 11 types of vibration isolating units which utilize steel springs, rubber and cork — singly or in combination. Discusses relative merits of springs and organic materials and tells under which conditions the various media perform best. A selector chart shows recommended and alternate methods of isolation. The Korfund Co.

158 Protective Lining — T-Lock Amer-Plate, a protective lining for concrete pipe and structures, is described as to properties and uses in this 8-pp folder. Photos show production of this acid-resisting sheet from synthetic resins, pigments and plasticizers. Other photos show some installations. A table presents sheet sizes for both ¾ and full lining of pipe diameters from 30 to 72 in. Amercoat Div., American Pipe & Construction Co.

. . . Good Suggestions on Welding, Drafting

159 Welding Rod Guide — The 32-pp "DirectoRod Guide" describes over 300 low heat input metal joining applications and procedures. Text and illustrations cover welding and overlaying all base metals using all heating methods. Recommendations are given for welding cast iron without pre-heating and dismantling, use of low-cost alloys, joining "difficult" metals. Company's Low Temp EutecRods and Lo Amp EutecTrodes are described. Special sections on tool tipping and wear resistant overlays are included, and practical metal joining procedures are given. Eutectic Welding Alloys Corp.

160 Drafting Made Easy — "Simplified Drafting" is a well organized 36-pp booklet presenting 11 common sense rules for simplifying drafting practices. Through the medium of sample drawings of engineered parts and assemblies, the 11 rules — from the use of word descriptions for simple parts to making freehand drawings where possible — are illustrated and a comparison made between simplified methods. American Machine & Foundry Co.

161 Steel Grating, Treads — Bulletin 2486, 16 pp, describes types, sizes and load characteristics of company's line of electroforged steel and interlocked aluminum grating and treads. Points out advantages in design and construction resulting in greater safety, pictures various applications, and includes specifications, photos and diagrams. Blaw-Knox Co.

162 Sectional Duct Furnace — Specifications and operating data on a new series of sectional duct furnaces are given in Bulletin B-55-D8. Includes a section on

Allis-Chalmers presents the new

HD-11

ANOTHER BIG STEP AHEAD IN LOW-COST COAL HANDLING

90 net engine hp
75 drawbar hp
20,500 lb

...with all the important performance advantages of Allis-Chalmers advanced basic design...tested and proved over millions of operating hours!

All-Steel Box-A Main Frame that soaks up shock loads, makes possible the service simplicity of unit construction.

Exclusive One-Piece Steering Clutch and Final Drive Housing with all final drive gears straddle-mounted on tapered roller bearings to insure long life.

Unit Construction lets you remove engine, master clutch, transmission, steering clutches and final drives without disturbing adjacent parts.

1,000-Hour Lubrication Intervals for roller bearing truck wheels, idlers and support rollers... makes production time out of service time.

Dual-Range Constant-Mesh Transmission lets you go from any forward speed to any reverse speed by shifting only one lever. Eliminates double shifting! That means faster work cycles... more production!

NEW STANDARDS OF PERFORMANCE AND LONG LIFE ON A WIDE RANGE OF JOBS

You owe it to yourself to investigate the performance advantages of the HD-11... newest addition to the Allis-Chalmers leadership line. See your nearby Allis-Chalmers dealer now.

New Allis-Chalmers Diesel Engine with "follow-through" combustion and tornado turbulence . . . for smooth engine performance, cleaner combustion, extra long engine life.

New Wrap-Around Radiator Guard used as dozer lift frame to simplify design, reduce cost of bulldozer; guard tilts forward for easy service.

New Master Clutch with Ceramic Lining sets new standards of clutch life . . . with fewer adjustments required.

New Operator Convenience including roomy, flat platform . . . foam rubber seat . . . 24-volt direct electric starting . . . 60-gal. fuel tank

Tough New Track — New design, through-hardened with extra toughness for long life even in severe abrasive conditions.

PLUS ... new, all-weather cooling; independent radiator-core mounting; new strength and capacity in final drive gears, shafts and bearings.

ALLIS-CHALMERS

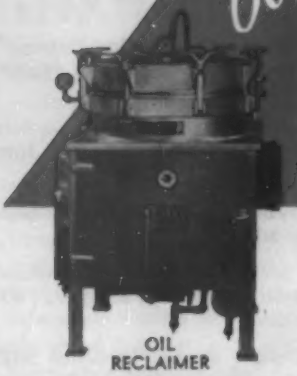
TRACTOR DIVISION — MILWAUKEE 1, U. S. A.

HILCO OIL RECLAIMERS

REMOVE WATER, SLUDGE, ACID

for complete

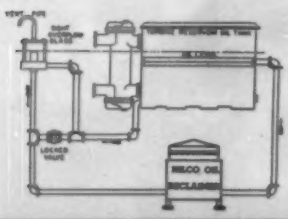
TURBINE OIL CONDITIONING...

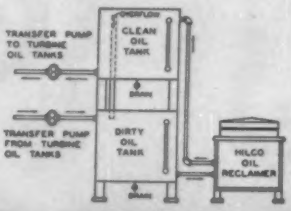


OIL RECLAIMER

The HILCO Turbine Oil Reclaimer is a self-contained, compact unit that will produce and maintain oil free of all solids, sludge, acids, moisture and air, keeping the oil in first class condition. Its purifying process is a continuous, all electric, automatic operation, requiring infrequent attention. It removes contaminants as fast as they are formed, maintaining lubricating oil at full value of new oil. HILCO Oil Reclaimers will also purify compressor, hydraulic, insulating, Diesel and gas engine lube oils.

Purifies Turbine Oil by Continuous or Batch Purification . . .





A continuous, direct-connected, foolproof oil reclaiming system. Oil flows from turbine reservoir tank to sight overflow glass, to HILCO Oil Reclaimer, and back to reservoir.

A batch system designed to serve one or more turbines when it is desired to withdraw all the oil from reservoir for complete periodic batch reclaiming to restore all oil as good as new.

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★ WRITE FOR THIS FREE BOOKLET TODAY . . .

FOR MORE INFORMATION ON HILCO TURBINE OIL RECLAIMERS . . .

THE HILLIARD Corporation

162 W. FOURTH STREET ELMIRA, N. Y.

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methods of installation and table of suggested combinations for achieving desired total capacity. Reznor Mfg. Co.

163 Crystalite Refractory — Bulletin CR-11, 12 pp, covers company's high-temperature Crystalite refractories, telling how improved techniques result in high resistance to thermal spalling and structural spalling, and to deformation at high temperatures. Tables list physical and chemical properties of Crystalite grog, Crystalite refractory, and Crystalite A refractory (a high-temperature, high-strength type). Includes photos, thermal conductivity chart, and case history installations. Richard C. Remmey Son Co.

164 Power Room Exhausters — Detailed information and performance tables on company's axial mushroom power room exhausters designed specifically for warehouses, industrial buildings, laundries, power plants, and wherever roof ventilation is applicable, either with or without duct systems, are in 8-pp Bulletin CAM-102. Chicago Blower Corp.

165 Centrifugal Air Washers — Bulletin W-555 describes company's centrifugal air washers for wet dust collection. Among applications listed are control operations for carbon black, soapstone, talc, pigments, and other powders liberated in the manufacturing of rubber goods. Cites specific applications in the recovery of fines from soaps, detergents, food products, drugs, chemicals, ceramics, and wallboard. The Ducon Co.

166 On Dehumidification — Twelve-pp Bulletin R-11 is a technical discussion on dehumidification of compressed air and gases with company's Driline high pressure dehumidifiers. Chapters are devoted to moisture load calculations, water cooled dehumidifiers, refrigeration cooled dehumidifiers, sorption units for low dew points. Applications for the systems described are also covered briefly. Desomatic Products, Inc.

167 High Capacity Feeder — Bulletin 37-M1 and AR-8 feature company's "Hi-Weigh," a belt gravimetric feeder for continuously feeding dry materials at medium to high rates. Tells how feeder maintains accuracies within 1 per cent. Dimension drawings and photos are included. Omega Machine Co.

168 Portable Oil Filters — Bulletin 316 introduces company's line of portable Hyflow oil filters. Discusses oil maintenance ability and lists uses. Includes illustrations of some models and provides specific data. Combination portable oil filters-oil reclaimer units are also treated. The Hilliard Corp.

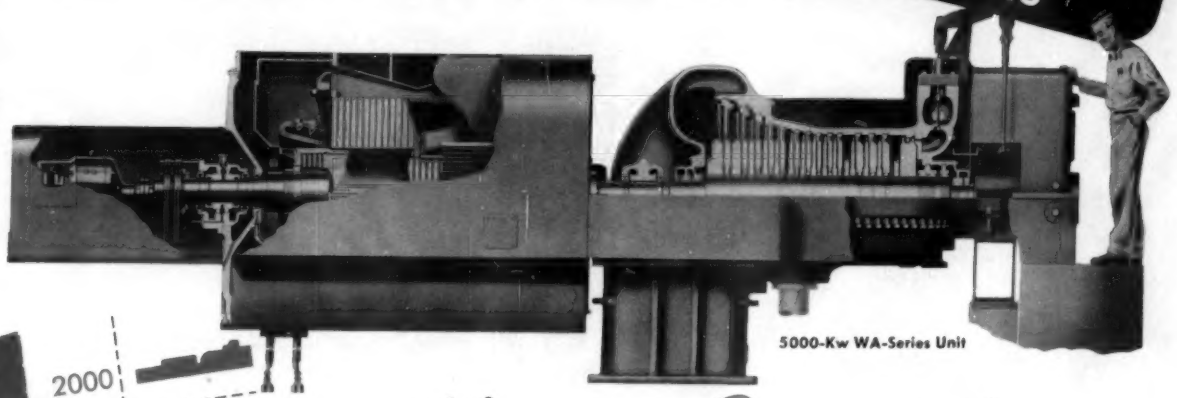
169 Pulverizers, Feeders — This revised general catalog contains sections on company's Pulva-Sizers for granulating, wet milling and fine grinding; Com-Bin feeders for storing and feeding mastic, plastic, sticky materials or dry solids; and auxiliary equipment. The section on Com-Bin feeder now includes additional surge capacity and dimensional data for all sizes from ½ cu ft to 857 cu ft capacity. Pulva Corp.

170 For Faster Coal Handling — Swive conveyors, all-in-one conveyor units, car unloaders, and other coal handling equipment including a direct bin-to-stoker screw conveyor, are described and pictured in this bulletin. Also shown are coal transport body and self-unloading coal body. Baughman Mfg. Co., Inc.

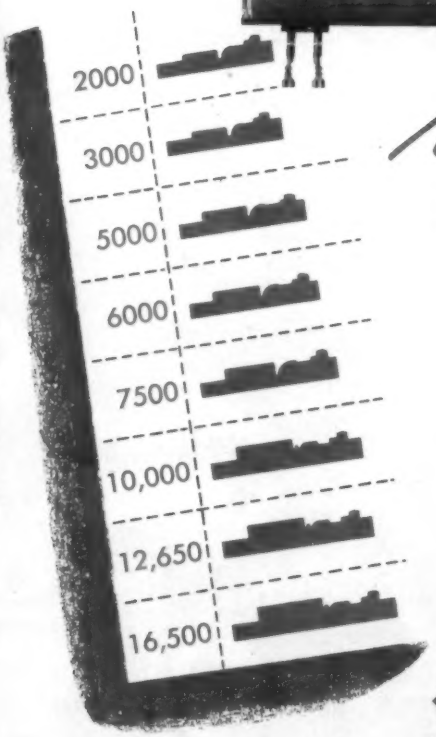
Now

WA-Series Extended To 16,500 Kw

WA-Series STEAM TURBINE GENERATOR UNITS



5000-Kw WA-Series Unit



Modern, Compact Units meet wider plant needs

Now you can get WA-Series steam turbine-generator units in new, higher ratings. Already operating across the country in NEMA ratings from 2000 to 7500 kw, these completely modern units are now available in AIEE-ASME preferred ratings to and including 16,500 kw.

WA-Series steam turbine-generator units provide power only or power as a by-product of process steam. They are attractive, compact units that have many of the "big turbine" features for which Allis-Chalmers is famous.

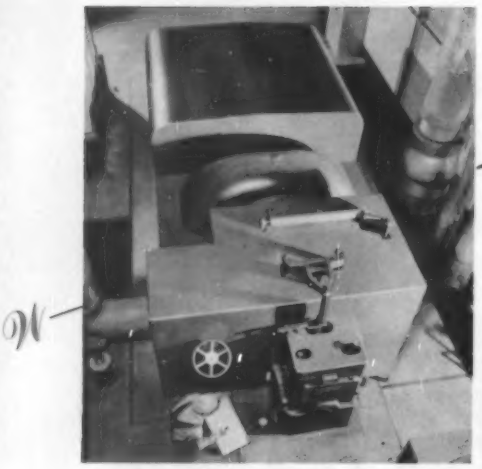
For example, the accurate, reliable centrifugal speed governor is the same type used in large Allis-Chalmers steam turbines. Steam seals are the same trouble-free labyrinth type used in turbines up to 300,000 kw.

For information on application of these modern, economical generating units, turn the page.

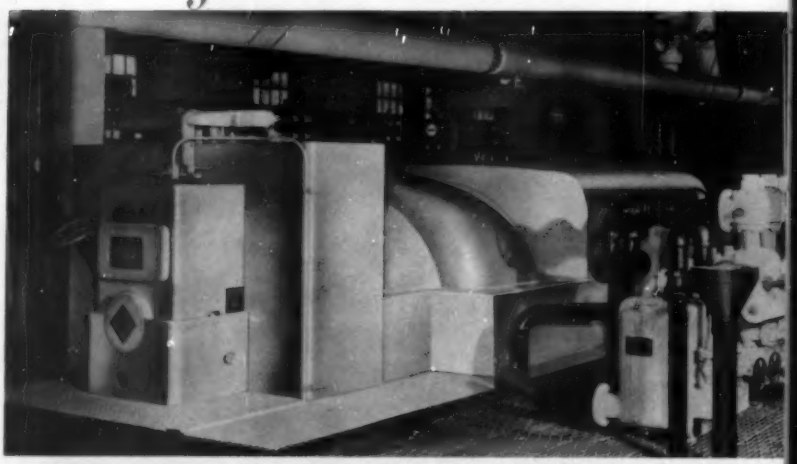
A-4810

ALLIS-CHALMERS

For Modern Power

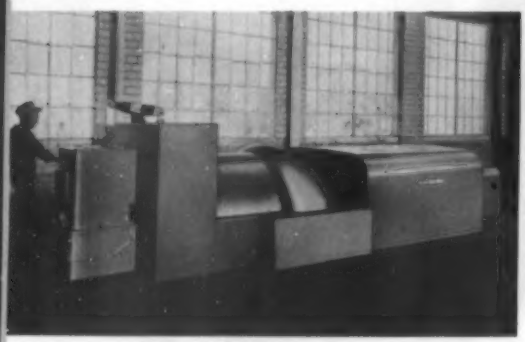


MANUFACTURING PLANT in Wisconsin uses this 7500-kw automatic extraction condensing unit in its power house. WA-Series unit generates power as by-product of process steam.



MINING OPERATION in Southwest gets power from a 5000-kw condensing unit. Waste heat from reverberatory furnaces is used for generating steam.

PAPER MILL in Wisconsin uses this 5000-kw non-condensing WA-Series unit to obtain both power and process steam for paper manufacturing. Photo at right shows generator end of unit.



UTILITY SERVICE in Ohio is provided by 3000-kw condensing WA-Series steam turbine generating unit.

WA-Series
STEAM TURBINE GENERATOR UNITS

ALLIS-

Plants Everywhere

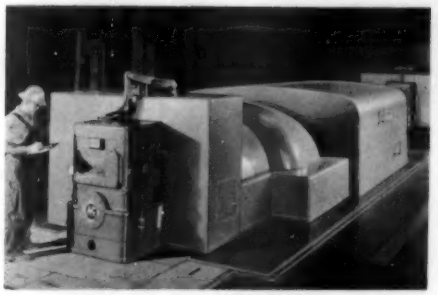
● Installations throughout the country are proving the low installation and operating costs of modern WA-Series steam turbine-generator units.

Maximum simplicity is assured by three-bearing construction. A bracket-bearing, housing type air-cooled generator is used for smaller units. A hydrogen-cooled generator is used for 16,500-kw units. Basic engineering features include labyrinth steam seals throughout, removable external glands, high chrome alloy steel buckets and nozzles and a time-proved governing system.

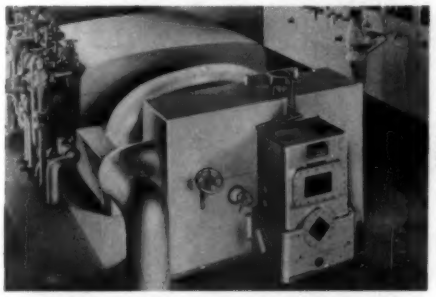
Installation is simplified because WA-Series units are factory assembled, and shipped on a single flatcar. Turbine and generator rotors are individually locked securely in place. All manufacturing and testing takes place in a single plant.

Foundation cost is reduced because oil piping and generator air coolers are above the floor line.

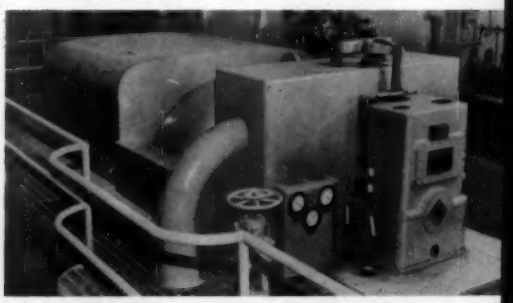
To get more facts on these economical units, call the nearest A-C district office or write Allis-Chalmers, Milwaukee 1, Wisconsin for Bulletin 03B7654.



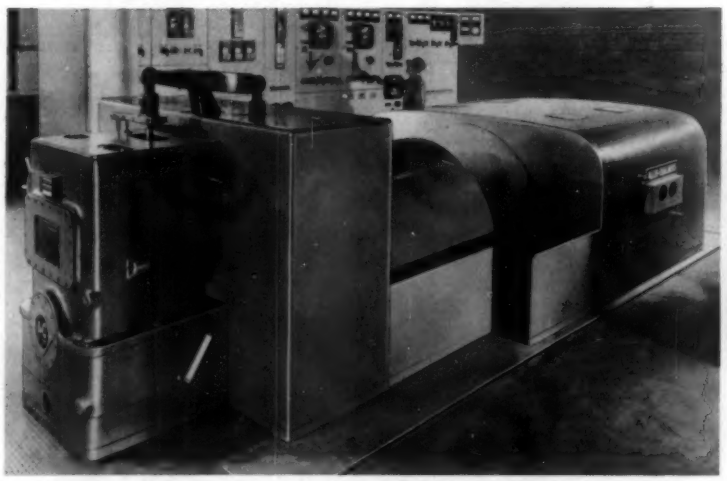
CHEMICAL OPERATION in Illinois uses two 5000-kw automatic extraction condensing units which generate power as by-product of process steam needs.



UTILITY in Florida uses two 5000-kw condensing WA-Series units to supply power for consumer needs.



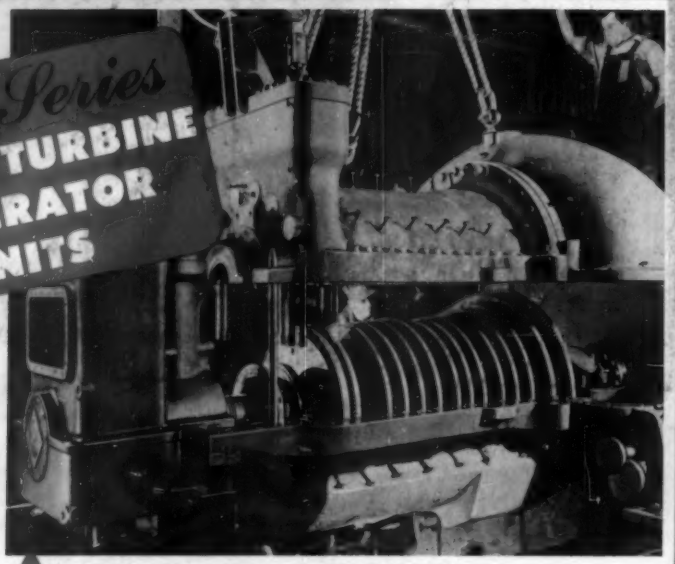
CEMENT PLANT in Kentucky obtains electric power from a 5000-kw condensing WA-Series unit. Steam is produced with waste heat from kilns.



GRAIN PROCESSING in Wisconsin requires power and vast quantities of process steam 24 hours a day, 7 days a week. A 2500-kw non-condensing unit supplies power as by-product from process steam.

CHALMERS

A-C ALLIS-CHALMERS

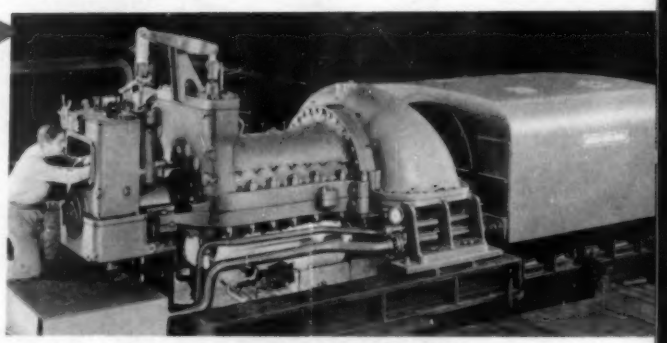


▲ Above: Precision balanced turbine rotor is lowered into casing during manufacture of a WA-Series steam turbine generator unit. One example of the quality designed into these units: all wheels have durable chrome alloy steel buckets.

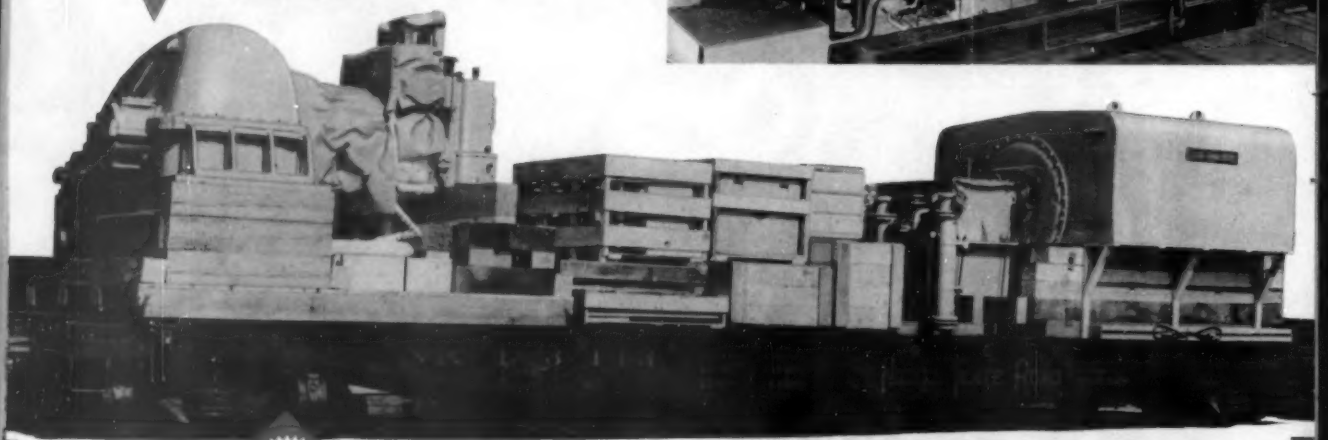
▲ Next step in assembly is addition of upper half of the turbine casing. WA-Series units provide the benefits of more than 50 years of Allis-Chalmers experience in designing and manufacturing steam turbine generating equipment.

Precision Built
For Fast Installation

Assembled 3-bearing unit—complete with housing type generator — is factory tested. Both oil piping and generator gas coolers are above the floor line, simplifying installation and service.



An entire WA-Series unit—pretested and insulated—is loaded on a single flatcar for shipment. Both turbine and generator are shipped with their rotors locked securely in place. Below, a ▼ 7500-kw unit in transit.



A-C ALLIS-CHALMERS

ALLIS-CHALMERS

Milwaukee 1, Wisconsin

ANTI-PARALLAX

MAXIVISION

is yours in this new thermometer

Now you can read temperatures *right at the process* with the same ease, accuracy and economy as pressure readings. The Anti-Parallax Maxivision Dial on this new all stainless steel American Bi-Metal Thermometer assures these important advantages. The large, easy-to-read black figures and graduations are carried on a raised ring set close to the glass, with pointer at the same level. Parallax error is practically eliminated.

With this new thermometer in service, field operators can eliminate frequent trips to the control house to observe process changes. Indoors or outdoors, this fine, all stainless steel American instrument is truly climate-proof. Because the case is only 3" in diameter, the thermometer fits where space is limited. Ample clearance behind the case makes installation easy and fast with a small wrench. Read the specification highlights, then get full details about this new high-accuracy American Bi-Metal Thermometer.

PHONE your Industrial Supply Distributor for prompt attention to your needs. He is always ready to help keep your production going by making fast delivery from local stocks.

SPECIFICATIONS

New AMERICAN ALL-STAINLESS STEEL BI-METAL THERMOMETER with ANTI-PARALLAX MAXIVISION DIAL

Dial: Exclusive anti-parallax Maxivision dial, with scale approximately 6" long. Pointer set at same level as scale.

Climate-Proof Case: All stainless steel. 3" diameter. Threaded bezel. Selected clear, extra-heavy cover glass. Heat-resistant gaskets between glass and case seal the thermometer against rain, frost, sand, dust, fumes—climate-proof.

Temperature Ranges: From minus 80° to plus 1000° F. Accuracy within 1% of range.

Low-Mass Bi-Metal Coil: Welded to stem plug. Accurately centered in stem. Non-freezing, non-corrosive silicone fluid on coil dampens vibration, accelerates heat transfer, speeds response; does not gum, resists capillary action.

Pointer: Index type. Easily accessible from front of dial for positive adjustment over entire range. Pointer shaft guided by friction-free bearings.

Stem: 18-8 stainless steel, mirror polished. All joints welded. Resists corrosion. Provides strong, rigid and tight closure against process pressures. Lengths: 2½" to 24".

Connection: Fixed, ½" N. P. T.

Separable Sockets: Available for use in closed systems or where measured medium is corrosive to the stainless steel stem. Fit over all standard stem lengths except 2½".

AMERICAN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'AMERICAN-M!CROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, *Stratford, Conn.* HANCOCK VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

For more data circle 549 on Post Card

EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 119–120 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—TIME SWITCH for control of intermittent operations

This 24-hr time switch makes control of intermittent operations, including day or night shutdowns, completely automatic, it is announced. The unit is especially adapted for marginal operation of oil well pumps and accurate cycling of processing equipment; heating, ventilating and air conditioning systems; stokers; oil and gas burners. The dial is scaled in 15-min graduations which can be set for as many as 48 "on" and 48 "off" operations, automatically repeating a 24-hr schedule. Adjustment for the complete schedule is simply and easily made, company says, by sliding the self-contained, non-removable trip levers in or out on the dial. Switch is available with or without a calendar device to cut out non-working days — completely selective for all seven days. Over-all dimensions are 8¼ in. high, 6½ in. wide and 4½ deep. Rated capacity of the single-pole double-throw switch is 1000-w; it operates on 60 cycle, a-c, 110 or 240 v. Zenith Electric Co.

2—ROTARY LATCH is simple, economical fastener

The Paneloc Rotary Latch is said to satisfy the need for a simple and economical yet strong and durable fastener for use on hinged or removable parts, such as inspection doors, access panels, covers, electrical control panels, machinery doors. Made of steel, cadmium plated, the latch consists of four parts: latch-screw, shim plate, anchor block and latch-nut. According to company, the entire latch is assembled on the access panel only, which eliminates several operations required to install other types of fasteners. Company maintains it saves space, weight, time and cost but still does an excellent fastening job. Three standard sizes are available, but other sizes may be furnished on special order. Scovill Mfg. Co.

3—LOW-VOLTAGE SWITCHGEAR, metal-enclosed, with walk-in aisle

Available in indoor and outdoor arrangements, this low-voltage metal-enclosed switchgear features circuit breakers rated 600 amp, 25,000 aic at 600 v, and 1600 amp, 50,000 aic at 600 v. Reversible panels are mounted on each breaker to let doors close with breakers in the connected, test or disconnected position. Each breaker compartment is barriered from the bus compartments by a double steel wall. The bus in each switchgear unit consists of a set of vertical risers braced with strain insulators to withstand mechanical forces exerted by short circuit current. The main bus is supported by these risers in each unit and additional bracing is accomplished by strain insulators between phases. The outdoor unit has a weatherproof housing and wide aisle between exterior panel and front of breaker compartments to protect operator from adverse weather — it's wide enough to let breakers be withdrawn within the structure. Bulletin 18B8283 describes this low-voltage switchgear. Allis-Chalmers Mfg. Co.

4—INTERNAL TUBE CUTTER has high cutting speed

This Internal Tube Cutter, it is announced, can cut out 280 1-in. by 14-gage Admiralty tubes from a heat exchanger in 45 minutes. Cutter is of heat-treated alloy steel, and has double cutters of tool steel which can be replaced when worn. In operation, cutter is inserted in the tube and in a matter of seconds, company points out, it cuts tube behind the tube sheet. Tube removal tools which may be used to remove tube stubs remaining in sheet after cutting are also available. The cutter is self-centering, and is powered by an air-driven motor. A ball bearing collar is adjustable for various tube thicknesses from 1 to 4 in. The cutter can be used on both steel and non-ferrous condenser tubes from ⅝ to 1 in. OD. The Airetool Mfg. Co.

5—PISTON PACKING is made entirely of nylon

Pumcups — cup type composition packing — are now available made of 100 per cent nylon composition. The result of research, development and field testing, the nylon cups are claimed to be considerably stronger than conventional compositions and show marked gains in service life. Bulletin 5503 gives further details. Darling Valve & Mfg. Co.

6—CHECK VALVE for high pressure hydraulic, pneumatic use

The 2300 Series of check valves is offered to meet the need for a dependable leakproof low cost unit in the 0 to 10,000 psi range. Manufacturer says the floating poppet design utilized is not affected by foreign particles in the fluid and eliminates "wire drawing" across the seat. Also, the spherical metal seat is designed to provide perfect seating and support for the O-ring which serves as a sealing member and absorbs the closing shock. Announced as suitable for most high pressure hydraulic or pneumatic applications, for virtually any liquid or gas service. This valve is of one-piece construction and is available in several body and O-ring materials combinations. James-Pond-Clark.

7—SOLENOID ACTUATOR is compact, electro-magnetic unit

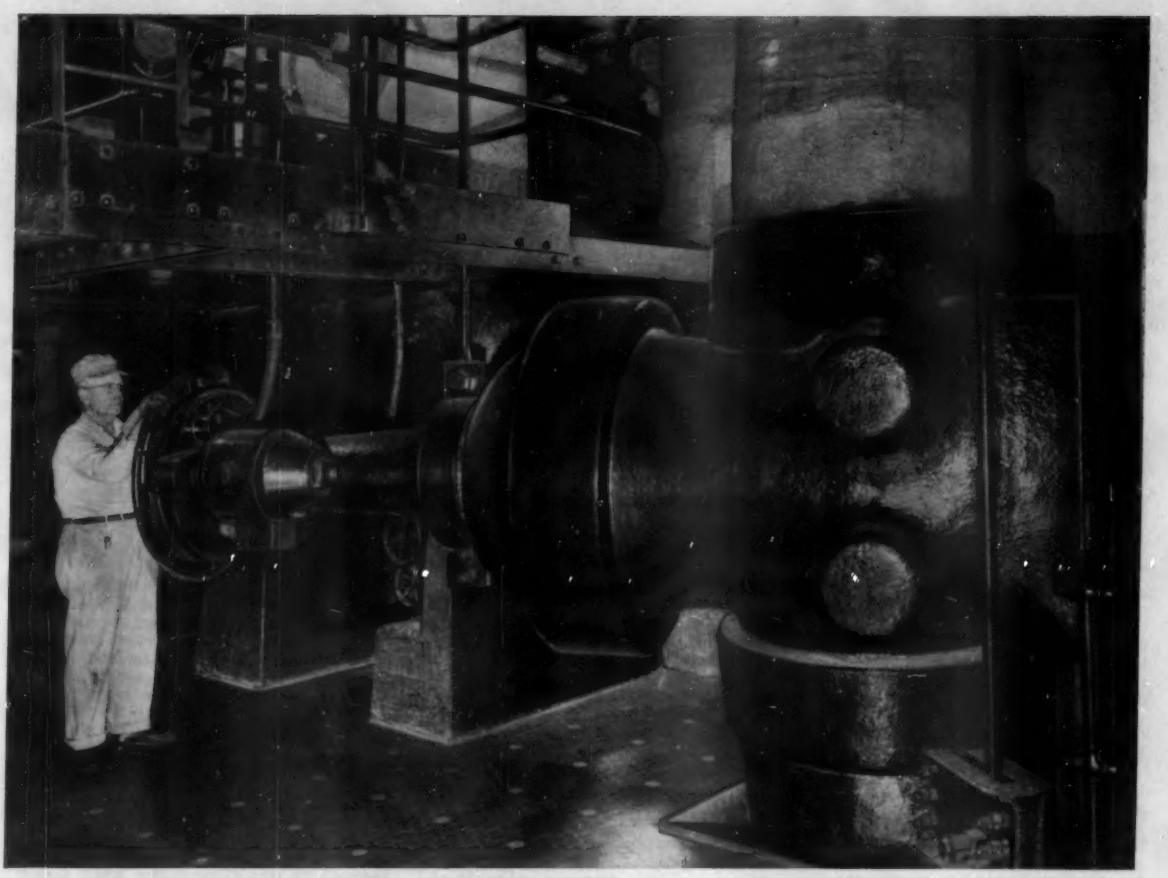
Outstanding feature announced for the Model L22A Solenoid Actuator is the linkage system available in either a push or pull arrangement, which magnifies the original air gap movement in an 8

to 1 ratio. Extremely compact — displacing 1.4 cu in. and weighing 50 grams — this actuator is designed to operate on 1.8-w input, within 7 milliseconds at normal voltage. According to manufacturer, the new linkage design permits even motion with minimum friction-induced loss of energy, and the actuator remains cool in continuous operation. Applications for the actuator include reciprocating motion, vibration generators, rotary step motion, model actuators, valve actuators, remote switches. James Cunningham Son & Co., Inc.

8—CONTROL SYSTEM for multiple-burner boilers

Fireye Integrated Control System is especially designed for safe lightup and operation of multiple burner boilers. It consists of a prewired and tested control cabinet assembly, plus all necessary controls, timers, valves and accessories. It provides starting and operating flame failure protection for one, two, three or four burners: gas, oil or gas-oil fired; manually or semi-automatically ignited. Flame failure protection is provided for each burner by two Type 48PT1 Scanners; one monitors the pilot flame, the other the main flame.

The system does not allow main fuel valve to open until pilot flame is established, says company. It makes mandatory a purge of time sufficient to produce four air changes in boiler, at end of which time a green light flashes to show operator he may continue "light-off" procedure. A timer limits the trial-for-ignition for each burner to ten seconds, after which fuel valve closes if main flame is not ignited. When flame



Dividends from this Crane valve over 30 years... 6¾ billion kilowatt-hours

Over thirty years ago, this 30-inch Crane steel gate valve was put in service at Commonwealth Edison's Crawford Station in Chicago.

As of May, 1955, unit No. 1 on which this motor-operated valve is installed, had been in operation more than 150,000 hours. Total power output generated with this valve in service was approximately 6,750,000,000 kilowatt-hours.

The valve is on reheat steam service with working conditions of 100 psi. at 700 degrees F. Never out of the line, and given but routine maintenance attention since installed in 1925, the valve's performance remains completely satisfactory.

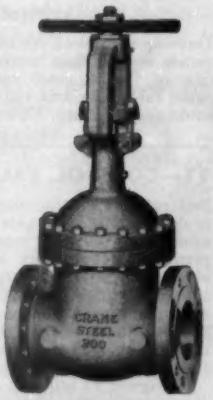
Seating action is positive and tight; bonnet-joint and stem seal are tight; operation is smooth.

There is nothing special about this rising stem, cast carbon steel valve—nothing but its dependable Crane quality. Development of steel valve castings was pioneered by Crane; long life and low maintenance are deeply rooted characteristics of Crane valves.

In steel valves, as in other materials, the Crane line is most complete: gates, globes, angles, checks and stop-checks—bolted, Pressure-Seal, and Lip-Seal bonnet designs—screwed, flanged, or welding ends—sizes up to 24 in.—pressure classes up to 2500 psi.

Your Crane Representative can give valuable help in specifying and ordering.

Crane Co., General Offices, Chicago 5, Ill. Branches and Wholesalers serving all industrial areas.



CRANE CO.

VALVES • FITTINGS • PIPE
KITCHENS • PLUMBING • HEATING

CRANE'S FIRST CENTURY...1855-1955

For more data circle 525 on Post Card

failure occurs, an alarm-horn sounds and a red light for that burner is flashed, remaining on until burner is restored. Installation Bulletin CC-31 gives more details. Combustion Control Div., Electronics Corp. of America.

9—CONVERSION KIT for transformer units

This kit is designed to permit easy conversion of company's standard, epoxy resin cast, window-type 600-v indoor-outdoor type current transformers to 5000-v insulation class bar type transformers. Components (shown) consist

of an insulated primary conductor, two primary bushing inserts, two primary terminal pads, and necessary gaskets and instructions. With the help of the kit, you can save on light duty metering transformer stock requirements and reduce the cost of 5000-v units over conventional design, it is pointed out. And for outdoor service it simplifies handling because weight and size are reduced.

The primary conductor is a copper rod threaded at both ends and insulated by epoxy resin cast over its complete unthreaded portion. The primary bushing inserts, which fit into the transformer's primary opening and through which the primary conductor passes, are also of epoxy resin. The primary terminals, when installed, hold conversion assembly together. Allis-Chalmers Mfg. Co.

10—STEEL VALVES for the super critical applications

Development of valves for a super critical power station has resulted in this new line of forged steel valves. They are rated for 7250 psi at 700 F; 10,800 psi at room temperature. Edward Valves, Inc.

11—CONTROL VALVE OPERATOR is electro-hydraulic unit

Self contained, this electro-hydraulic control valve operator is designed to eliminate need for air supply and compressor systems to operate controllers for process variables such as pressure, temperature and flow. An addition to company's electronic process control instruments, it makes available an integrated graphic-type process control system operated by electrical power. Such a system is reported especially desirable where long transmission distances are involved, where freezing or clogging of pneumatic tubing may be a problem, and where the cost of air supply systems is excessive.

Designed to position conventional slip-stem control valves, this operator uses hydraulic force developed by a self-contained pumping unit supplied by 115- or 230-v electrical power. The operator accepts the 0.5 to 5.0 ma d-c signal of company's American-Microsen transmission and control systems. Under proper conditions, the transmitter can be separated 30 miles from controls and control valve operator. Signals received by the latter may include proportioning, reset and rate actions.

Another product, an electro-hydraulic controller-operator, is a modification of the control valve operator using the same principles and incorporating proportional and reset control actions. It is operated directly from a transmitter and is used on local control operations not requiring the remote operating controls. Manning, Maxwell & Moore, Inc.

12—LINEMAN'S BELT offers safety; more freedom and comfort

Claimed to be the safest and most comfortable of belts, the Bak-Saver is designed to let a lineman be higher on his work without risking falling out of the saddle. With it, he can work further out from the pole with greater freedom, it is stated. According to manufacturer, this strong yet lightweight belt combines the protection of a safety belt with the comfort of a back support. The support portion of the belt is russet strap leather, ventilated for comfort. Tool saddle and dee saddle are made from russet steer harness leather for strength. Manufacturer says the Bak-Saver permits wearing belt in a low, comfortable position, and it firmly supports weight of tools. Miller Equipment Co., Inc.

13—WATER SOLUBLE LUBRICANT helps to prevent rust

Designed for use in connection with tube expanders, this water soluble lubricant is reported effective where the use of oil in tubes is objectionable. It prevents rust, acts as a coolant and is easily washed off the expander, manufacturer points out; also it does not become sticky. Reports indicate that the lubricant increases life of expander rolls and mandrel. Available in 2-lb cans, it contains a paste which is mixed with water, approximately six parts of water to one of lubricant. For heavier duties, such as with large boiler expanders, this lubricant should be made almost a slurry. Lagonda Div., Elliott Co.

14—"FADE OUT" PAPER for tracing, now comes in rolls

This time-saving paper is printed with light-blue cross section rulings which disappear on direct print reproductions and blueprints. Using the printed grid as a guide, scale drawings are easily and accurately made, says manufacturer; also freehand lettering is quickly applied, and pencil and ink lines can be erased often without "ghosting." Fade-out grid paper is suggested for wiring and plumbing diagrams; structural and schematic drawings; plant layouts. It is available in 20-, 50- and 100-yd rolls, in widths from 24 to 42 in., in 16- and 20-lb stock, with grid lines 8-by-8 or 10-by-10 to the inch. A catalog with sample sheets is offered qualified power engineers. Clearprint Paper Co.

15—ROOM AIR CONDITIONER is only 9 in. deep

UniTrane Room Air Conditioners for year-around conditioning of multi-room buildings are only 9 in. deep, it is announced, yet other dimensions and capacities remain substantially unchanged. Company's Delta-Flow Fin 2-row coil is said to provide as much heat transfer capacity as the larger 4-row coil previously used. Designed to fit any type of unit air conditioning system, four basic models are available: vertical cabinet units; vertical concealed units; horizontal ceiling-mounted cabinet units; and horizontal concealed units.

A special design feature permits conversion of either vertical or horizontal types from concealed to cabinet types and vice versa. Other advantages claimed are: easy, low-cost installation; reversible coils and drain pan; two-way outside air intake; quiet operation; and removable fan section. When supplied with chilled water, unit provides cooled and dehumidified air for the summer, and in winter, with hot water running through its coil, it circulates warm air. Units in unoccupied areas can be turned off without affecting the rest of the system. The Trane Co.

16—MOTOR BRAKE is mechanical in action

Built into the motor frame and enclosed in the housing, this mechanical motor brake is reported to save as much as 7⅜ in. in length, compared with many types of brakes. It allows for quick opening, company says, and avoids sudden impact on stopping. Tension springs can be adjusted for rapid or slower stops and four locking screws give any desired adjustment, precise tolerances not being required. Besides stopping gently, company notes, brake allows for smooth, easy acceleration from standstill to full load. The brake assembly is provided with fans for temperature control. These brake motors can be installed in any position and are designed for work requiring frequent braking. They can also be inched. The Cleveland Electric Motor Co.

17—GEAR LUBRICANT for highly loaded gears

Molykote 165X is announced for application on highly loaded gears which normally can be lubricated only infrequently. The lubricant is a near-colloidal dispersion of Molykote Microsize in a viscous, tacky and adhesive petroleum oil which has been rendered fluid by addition of a volatile non-flammable dilu-

HALL LABORATORIES, INC.—A SUBSIDIARY OF HAGAN CORPORATION, PITTSBURGH, PENNSYLVANIA

Hall Industrial Water Report

VOLUME 3 AUGUST 1955 NUMBER 4

It Takes a Lot of Water Conditioning To Operate a Steel Mill at Capacity Plus

The constantly increasing production of steel demands a constantly increasing stream of raw materials. Water, used in many ways, is one of the most important. More than 100 tons of water go into the production of every ton of steel, underlining the importance of water engineering to the steel industry. Hall Laboratories, through close cooperation with plant personnel, serves the steel industry, whether in routine control of daily treatment, or in solving the many special problems peculiar to the steel industry.

The Skid-Pipes Were Skidding

Difficulties with cooling water constitute the bulk of steel plant water problems. For example, in one steel plant, the water cooled skid-pipes on which billets are pushed through 2000°F reheating furnaces were buckling.

Investigation revealed that scale formation cut down heat transfer and caused the overheated pipes to fail. Threshold Treatment of the cooling water with Calgon® now keeps the skid-pipes free of scale, and the buckling of the pipes is no longer a problem.

Discoloration of Galvanized Strip Checked

Hall engineer B. Q. Welder reports on solution of a problem in the galvanizing mill of a large steel mill in the "Iron City."

"Galvanized strip unaccountably developed large dark discolorations some weeks after shipment. It seemed to me that the source of the discoloration might be in the rinsing operation.

"Following galvanizing, the strip was rinsed by immersion in and spraying with filtered river water. The last step in the process was a chromate-silicate rinse prepared with clarified river water. Carryout of solids from the rinses was responsible for the trouble.

"Since adopting our recommendation that condensate be used for the rinse following the immersion tank and in making up the final chromate-silicate rinse there have been no further reports of trouble."

Baffling Problem Solved

When the exchange capacity of a sodium zeolite softener in an eastern steel mill dropped to 8.2 kilograins per cubic foot from a rated capacity of 16 kilograins per cubic foot, plant personnel consulted their Hall engineer, D. E. Noll. To confirm his suspicion that hydraulic channeling of the resin bed was responsible for the loss of capacity, Noll tried an intermediate backwash to redistribute the resin. The backwash doubled the length of the run, indicating that channeling might be the trouble.

When operation permitted an inspection of the resin bed, Noll and the plant men found that although fissures had not broken through, high flow rates around the edges of the unit had pushed down the exchange material, and a cone had formed in the bed.

To step up the efficiency of the softeners, Noll suggested a baffle design that would insure even distribution of the incoming water throughout the exchange bed. When the units were returned to service with baffles installed, the exchange capacity came up to the rated 16 kilograins per cubic foot and normal regeneration practice was resumed.

Specialists in iron and steel metallurgy are skilled at transforming crude ore into finished metal. Like the technologists in steel, Hall Laboratories fits the treatment of a vital raw material, water, to the need in specific processes in the manufacture of steel.

New Control System Tested

A new system of automatic blowdown control developed by Hall Laboratories' research has shown in field trials that it maintains boiler water solids concentration within plus or minus 5% of the set point.

The equipment continuously determines the dissolved solids concentration in boiler water by measuring the conductivity of a flowing sample. A signal from the conductivity cell pneumatically controls the blowdown valve.

The new control system minimizes the possibility of carryover and allows close control of treatment under all conditions.

Booklet H-1, describing the Hagan Automatic Blowdown Control System, is available upon request.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information, write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

Water is your industry's most important raw material. Use it wisely.

Hall Laboratories, Inc.—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

For more data circle 526 on Post Card

ent. Evaporation of diluent leaves a plastic film that does not tend to hold dust, resists being washed off by water, and doesn't crack or peel off at temperatures as low as zero F.

Molykote Microsize present in this lubricant acts to protect gears from galling, welding and excessive wear when they are heavily loaded and are operating under boundary lubrication conditions. This lubricant is claimed to be particularly useful where only one or two gears of a long train are exposed and lubrication of train must be achieved through transfer of lubrication from gear to gear. It is applied by brushing, pouring, drop feed cups, spray gun or mechanical force feed lubricators. The Alpha Molykote Corp.

18—CURRENT TRANSFORMER with high mechanical ratings

Type JKS-3 Current Transformer is announced for indoor service and suitable for operating relays and control devices. It has been designed with extra high mechanical and thermal ratings to adapt it for relay and control device

operation. It is intended for use on circuits not exceeding 5000-v, line-to-line, and is available in all standard, single, primary-current ratings 15 to 800-amp inclusive. It is butyl-molded, a construction in which the butyl serves as insulating, support and casing. It will not crack from coil expansion nor from changes over a wide range of ambient temperatures, company notes, and will meet test requirements of the 5-kv Standard Insulation Class, which call for a one-minute 19-kv test at 60 cycles and a full-wave impulse test at 60 kv. Transformer is designed for continuous operation at 100 per cent of rated current in 55 C ambient temperature without exceeding the allowable 30 C rise. General Electric Co.

19—CONCRETE TYPE MATERIAL for flooring, construction

Laticrete "gives" without cracking under heavy loads, and dampens shock and noise, says manufacturer; it resists alkalis and mild acids, is waterproof and has a non-slip quality. The material is combination of liquid rubber and cement powder. The rubber content is said to make it extremely flexible and give the cured mix "bounce" and a tight bond that makes it resist breakdown.

This concrete-rubber mix is a surface coating and can be used for repair work or in new installations. It is reported to have good adhesion to concrete, metal and even glass. According to company, a ¼-in. layer of Laticrete (the suggested thickness) supports fork lift trucks when put down over a hard base. Laticrete comes in two parts — the powder and the liquid rubber — and is prepared like regular concrete with standard masonry equipment used to mix and apply it.

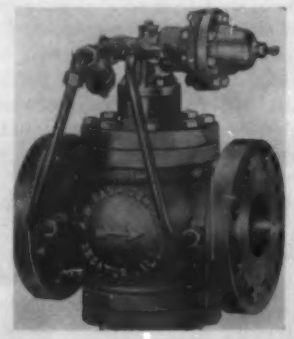
Manufacturer of Laticrete cautions that it must be applied to a clean surface, because dirt or foreign matter will prevent a bond. Also, any acid on the surface to be coated must be neutralized before application. The light gray mix can be pigmented in various colors. Its cost is announced as above that of concrete but below that of acidproof brick or tile. Naugatuck Chemical Div., United States Rubber Co.

20—VERTICAL MOTOR designed for pumping industry

This line of hollow-shaft vertical motors designed specifically for the pumping industry is available now in ratings of 40 hp and up, in frame sizes 404 through 6330, and in ratings from 7½ hp and up in early 1956. According to company engineers, installation, inspection, and maintenance has been made easier by using a lightweight cap (of aluminum in the larger sizes) which can be lifted by one man. When cap is removed, couplings and bearings are available for inspection, and installation attachments and impeller adjustments can be made without further disassembly. Motors are so designed that couplings can be changed in a few minutes with ordinary tools. Lubrication is simplified by a Vistamatic lubrication center providing an oil gage which can be read easily, company points out, and ample filler and drain plugs to facilitate adding and draining lubricant quickly. General Electric Co.

21—CONTROL VALVE with adjustable throttling range

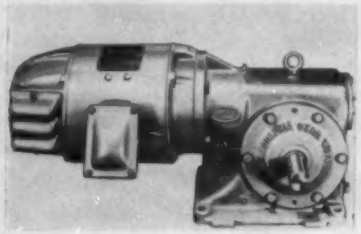
This company's Standard Type 10 is announced as an improved self-contained, single seat pilot-operated control valve with adjustable throttling range. It features easy conversion from a pressure reducing and regulating valve to a back pressure control valve by simply



switching control piping. A dial-type range selector is used to select throttling range necessary to give most stable and sensitive control for particular process involved. Valve can be used with water, gas, air, light oils and refrigerants, including ammonia and Freon. It is suggested for water systems, for altitude control, as an unloading valve on extrusion presses, for back pressure control and for oil refineries. It is available in iron, bronze or steel, with bronze or stainless steel trim, and monel trim on the pilot valve, and composition or metal seat. Sizes are from 2 to 12 in. with flanged ends, and from 2 to 3 in. with screwed ends. A. W. Cash Co.

22—GEAR REDUCER designed for severe industrial service

Complete and self-contained, this compact right angle worm gearmotor is announced as available in a wide range of sizes from 1 to 50 hp, having reduction ratios from 3⅛ to 1, to 90 to 1. It has been designed to give the most severe



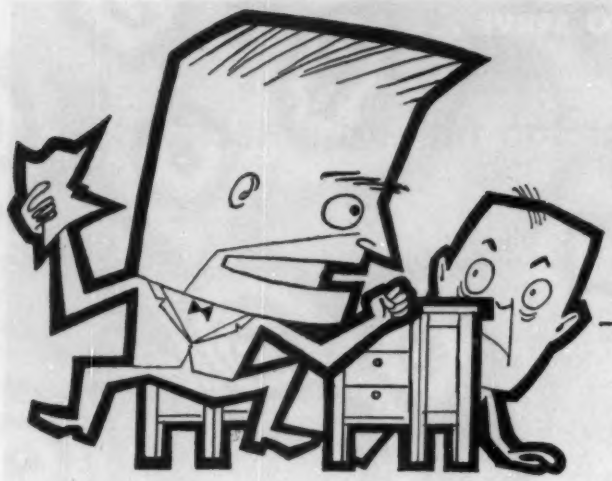
industrial service. Gearing and bearings have been oversized for maximum strength. An important design feature cited is that a flexible coupling connecting the motor shaft and worm shaft is enclosed within the gear unit. Thus, company states, the problem of alignment is eliminated. Due to its compactness, the gear reducer may be mounted alongside of equipment rather than in aisles. Neat appearance, quiet operation, and high efficiency are other advantages claimed. Catalog WG-A gives further data. Philadelphia Gear Works, Inc.

23—VALVE LUBRICANT has broad temperature range

This multi-purpose valve lubricant, the No. 555, is announced for a wide field of applications and temperature range. It is said to offer good metal-wetting qualities at both sub-zero and highly elevated temperatures and to be unusually resistant to mixtures of hydrocarbons in both acid and alkaline solutions. Claimed suitable for a wider range of services than many plug valve lubricants, the 555 replaces four other lubricants in company's line — Nos. 542, 546, 548 and 654. The new product has an efficient temperature range of −40 to 500 F in bulk form, it is pointed out, and −20 to 500 F in stick form. Company recommends it for hydrocarbon liquid and gas services — including gasoline, kerosene, fuel and lubricating oils, crude distillate, sweet or sour natural gas, LPG systems, dilute acids and alkalis, glycols, aqueous solutions and water. Meter and Valve Div., Rockwell Mfg. Co.

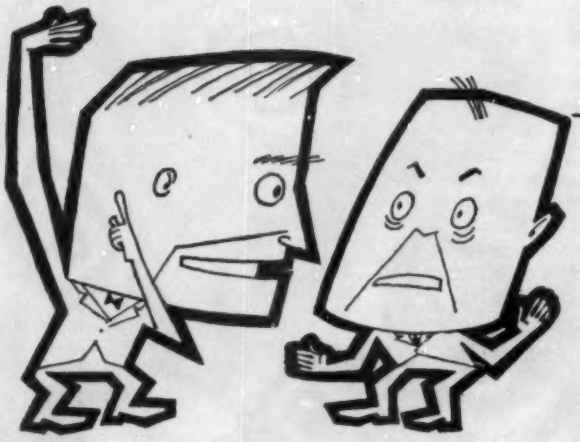
24—FEEDER BUSWAY reduces short-circuit current

Type CL high-reactance feeder busway design is said to permit interrupting capacities of more than 100,000 amp RMS symmetrical at transformer output terminals. The factory-assembled busway is designed for use in commercial and industrial buildings for connection between service entrance and main switchboard, or wherever it is desired



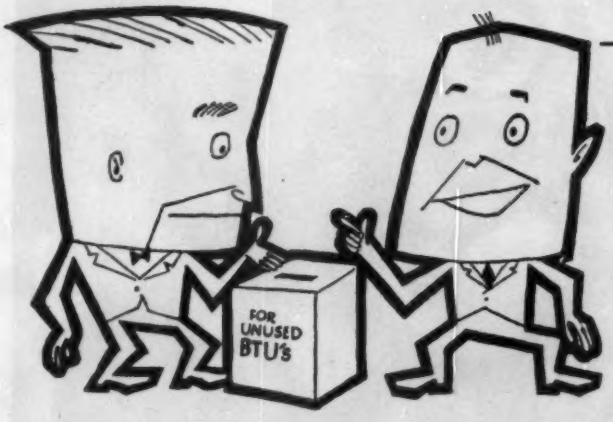
Fire the fireman! Here's another smoke summons.

Don't fire the fireman, he's doing his best. Let us look for a more adaptable coal.



What's wrong with the coal? It's high in BTU's.

Sure, it's a good coal—in the right furnace—but our set-up just can't supply enough air to burn all of the hydrocarbons before they cool off and blow up the chimney as free carbon.



There's no sense in buying BTU's we can't burn, is there?

You've got a point there—and one that so many people are never aware of. It isn't only what's in the coal that counts—it's what you can get out of it under your own set of conditions. That's why picking the right coal is a job for a competent combustion engineer. The superior quality coal produced at mines served by the Chesapeake and Ohio will meet our most exacting requirements. Before we sign another coal contract, let's get in touch with coal producers on the C&O or a C&O coal man to give us the facts and figures on which coal will cost us least in the long run.

P.S.

There's a lot more to buying coal than the cost per ton. For facts and figures to solve your particular fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake & Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

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B&W FM BOILERS GO TO SEA TO SERVE . . .

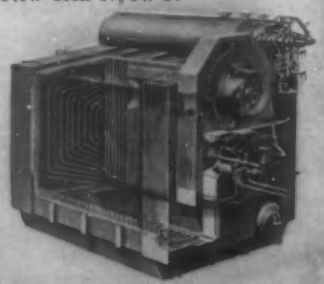
Another Watchdog for 165 Million Americans

Soon to rise out of the sea, this "Texas Tower" will stand on the continental shelf along the Atlantic coast. One of a number of unique radar platforms planned to strengthen national defense in the Air Defense Command's mission of defending the United States against possible enemy air attack, it will be installed in relatively deep water. The platform, housing billets, mess facilities, equipment and storage area will be well above the highest waves expected at the site. Part of the weather deck will be available as a helicopter landing area.

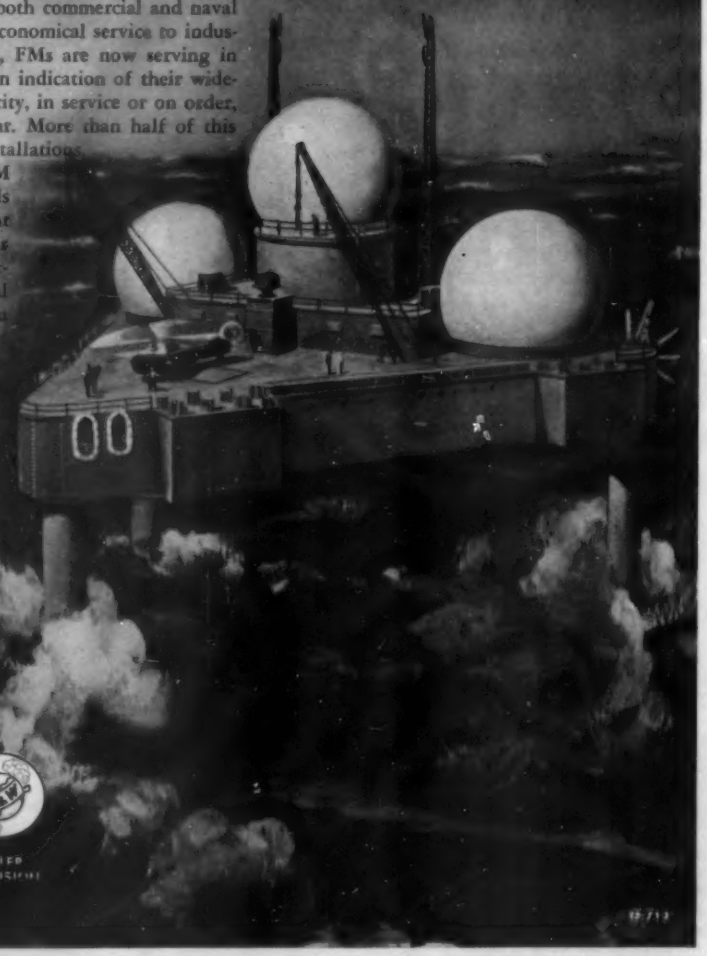
Out in the open sea, an installation of this importance must have steam generators that are completely reliable and efficient. The fact that two oil-fired B&W Boilers, Type FM have been selected to serve this unusual installation, is a tribute to their established reputation for dependable service. Having a 10,000 lb per hr total steam capacity, these units are equipped with electrical controls and safety features, are completely automatic, and require very little supervision. Operated alternately, each FM will individually carry the full steam load for heat, hot water, laundry, and cooking requirements.

In going to sea for this special job, B&W FM Boilers join all the B&W Marine Boilers supplying steam for both commercial and naval vessels. With a record of dependable and economical service to industries, utilities, institutions, and other users, FMs are now serving in virtually every category requiring steam. An indication of their widespread application is their total steam capacity, in service or on order, of more than 11,000,000 lb of steam per hr. More than half of this capacity is in space-saving multiple-unit installations.

Compact, versatile, the shop-assembled FM is available in standard sizes for steam loads ranging between 2900 and 40,000 lb per hr at pressures to 235 psi—is widely used for higher pressures and with moderate superheat. Whether your requirements are unusual or conventional, we'll be pleased to show you how the FM Boiler can help reduce the cost of your steam. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.



FM BOILER SIMILAR TO THOSE INSTALLED IN THE RADAR PLATFORMS



BABCOCK & WILCOX

BOILER DIVISION

For more data circle 535 on Post Card

to reduce available short-circuit current. According to company, design provides values of reactance which are from eight to 23 times that of many conventional feeder busways.

Busway serves same function as current-limiting reactor by reducing magnitude of short-circuit available at its output end. The use of busway in service entrances from secondary networks with available short-circuit currents higher than 100,000 amp RMS total asymmetrical current makes it possible to utilize standard switchboards, panelboards, and other electrical distribution system components, company points out. It can also be used in smaller-amp-rated installations for reducing short-circuit current between main switchboard and motor control centers which have maximum rating of 50,000 amp. Unit is enclosed in a ventilated aluminum housing 7½ in. deep by 29 in. wide for all three-phase and three-phase, four-wire busways in ratings from 1000 to 4000 amp. General Electric Co.

25—UTILITY KIT contains maintenance needs in spray cans

The Spray Line Utility Kit consists of four 6-oz aerosol (spray-type) cans — one each of company's lubricating oil, penetrating oil, rust inhibitor and All-Weather Clear-Coat. With these aerosol products, a man can spray the materials in and around hard-to-get-at places, and he doesn't have to clean containers and applicators after use. It is also pointed out that there is no loss due to evaporation or spillage, because the unused material is always under seal in the pressure can. Crown Industrial Products Co.

26—MANUAL RESET VALVES shut off fuel flow to burners

Fireye Series 81G Manual Reset Valves are designed for use with company's flame failure systems for use in shutting off the flow of fuels in oil and gas burners in case of faulty operation . . . flame failure, fan or pump failure, loss of

electrical power, others. According to manufacturer, the leakproof closing action of these valves protects against explosion hazards, and their foolproof manual reset mechanism prevents reopening unless the electric holding coil is energized. The valves are UL and FM approved, it is noted, and come in sizes from 1 to 4 in. for use with manufactured, natural or mixed, or LP gas, and in 1- and 1¼-in. sizes for use with pre-heated No. 5 or 6 oil. Bulletin CV-31 gives installation information. Combustion Control Div., Electronics Corp. of America.

27—CHLORINATOR has flow regulating mechanisms in one unit

Besides integrating all chlorine flow regulating mechanisms into unit, the Figure 1050-A Chlorinator is designed for quick adaptability to a wide range

of flow rates. It is vacuum operated, with water flow through the ejector-assembly producing the vacuum. Spring opposed diaphragms regulate chlorine flow in the vacuum system. These diaphragms — a differential-pressure regulator and a vacuum regulator — are combined into one unit or stack, which also contains a vacuum breaker valve plug and pressure relief valve. According to manufacturer, this simplified design permits a compact, lightweight mechanism (chlorinator weighs 70 lb), and offers low maintenance advantages.

To change capacity range the metering tube and, in some cases, the rate valve and ejector assembly are replaced with units of the desired capacity. The standard manually-operated Figure 1050-A Chlorinator can be converted to operation with pump sequencing systems, control programs, automatic proportioning and remote control by adding standard accessories. Company adds that the same automatic proportioning chlorinator can be used with primary flow measuring elements — differential-pressure, open channel and rotating meters — so that a single unit serves as a stand-by for multiple chlorinators operating off a variety of primary meters. Fischer & Porter Co.

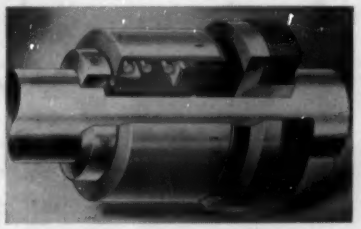
28—TAP CHANGERS for large step regulators

Type URT Tap Changer is announced for step regulators rated above 1500 kva. The mechanism changes taps under load on a regulating transformer to provide ± 10 per cent regulation in ⅝ per cent steps. Switching equipment is in two separate oil-filled compartments — one for selector switches, and one for transfer switches, separated from transformer tank by insulating Micarta barriers that prevent oil or vapor interchange and permit any compartment to be drained or inspected individually.

Moving contacts for selector switch, and stationary contacts for transfer switch, are spring-loaded copper bars with coin silver inserts for contact areas. Iron channels brazed to the copper bars act as electromagnets to increase contact pressure during fault current conditions to prevent contact welding. The transfer switch compartment has a pressure-relief valve in the gas space above the oil. This permits gaseous products of arc interruption to be exhausted, company points out, and prevents inbreathing of air that would accelerate oil deterioration. Each phase of both selector and transfer switches has its own inspection door, which can be easily removed by one man. Driven by a three-phase, 220-v motor, a geared drive shaft operates all phase assemblies simultaneously, as well as auxiliary cam switches. Westinghouse Electric Corp.

29—COAL TAR TAPE for pipes, is single-wrap type

Tapecoat-X is a single-wrap coal tar type for pipe, joints, fittings and couplings. According to manufacturer, Tapecoat-X offers double-wrap protection from single-wrap application, and with only ½-in. overlap. Advantages claimed include greater coverage due to the single-wrap feature; easier application through a separator film which facilitates unrolling and disappears in the application process; faster wrapping; and economy in material cost. Tapecoat-X comes in rolls in 2-, 3-, 4- and 6-in. widths. Tapecoat Co.



30—MECHANICAL SEAL comes ready to install on shafts

The BB-21A Mechanipak Seal is specifically designed for use on rotary shafts at pressures to 150 psi. It is furnished completely assembled, ready to install. Standard construction includes brass shell, brass washer, and Buna-N bellows. Seals are available for shafts from ⅜- to 3-in. diam. Buna-N or Neoprene bellows are furnished for operating temperatures to 212 F and pressures to 150 psi. Silicone bellows are provided for temperatures to 400 F where pressures do not exceed 50 psi. According to company, these seals eliminate wear on shafts and shaft sleeves, eliminate fluid leakage, and cut maintenance costs. Bulletin AD-150 gives complete information. The Garlock Packing Co.

Reader Service Cards on pages 119–120 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

31—CONNECTORS help reduce wire pulling effort

Tite-Bite Self-Insulated Connectors for terminating armored cable and flexible conduit are available in all conduit sizes, ½ to 3 in., both straight and 90 deg angle types. The insulated throat

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built into each fitting is said to reduce wire pulling effort by as much as 50 per cent, and protect wire insulation from abrasion damage during pulling. The ⅜ in. size (straight type) has a funnel-shaped insulating throat which also serves as a stop for cable armor, eliminating customary segmented metal shoulder and simplifying insertion of conductors through the connector. Insulator on this size connector is made of clear plastic to let inspector see that anti-short bushing is properly installed.

The fittings are said to be of particular advantage in motor housings subjected to continued vibration. Steel is used for ⅜ and ½ in. sizes, malleable iron in ¾ to 3 in. sizes. All have company's Tabolite protective finish. Instead of the screws formerly used, hooks on cap engage ears on the body and pressure of the double-grip clip on cable or conduit holds them together. Clip's fastening screw also holds entire assembly together. The Thomas & Betts Co.

32—RESET VALVE for emergency safety service

Type 73-20 Manual Reset Valve is announced for emergency safety services requiring quick, positive action. Combining simplicity of design with positive action, the valve has many applications.

It may serve as a safety shutoff in either liquid or gas fuel lines, as a safe open valve for steam or foam fire snuffing systems, manufacturer points out, or to shut down pipelines that indicate a line break by loss of pressure. It utilizes bodies, trim and topworks of company's diaphragm control valves with delatching trip mechanism to provide any usually specified requirement, with such response remaining effective until manually reset. Black, Sivalls & Bryson, Inc.

33—PVC PIPE FITTINGS are solvent welding type

This line of solvent welding pipe fittings and flanges of injection molded unplasticized polyvinyl chloride includes 90- and 45-deg elbows, tees, unions, couplings, caps, reducing bushings and flanges. According to manufacturer, solvent welding fittings permit fast, easy installation with a minimum of tools and equipment; and since both fitting connecting surface and pipe connecting surface are smooth, there is no notch effect. PVC piping systems fabricated with these fittings are suggested where installations are of a permanent nature. The threaded type is recommended where

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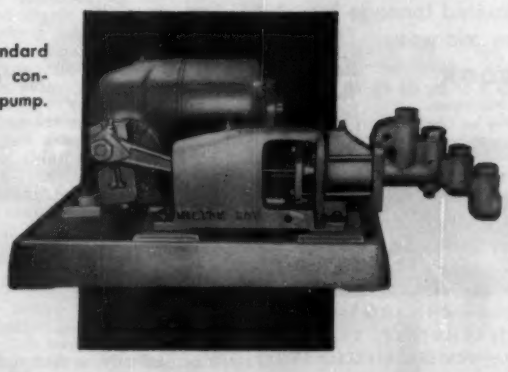

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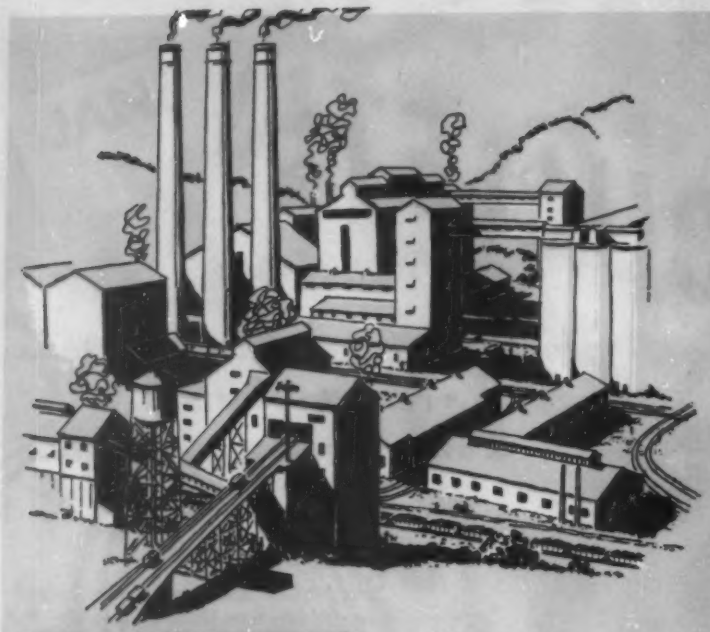

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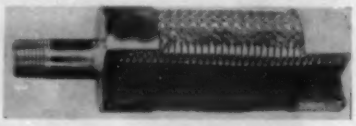
disassembly, revamping or revising of the system may be required. Solvent welded fittings are preferable in the erection of Schedule 40 piping, it is claimed, since they result in more durable installations. Tube Turns Plastics, Inc.

34—PRESSURE BURNERS for oil, gas, combination fuel

U.L. approved power pressure burners are announced as available in straight oil, straight gas, and combination-gas-oil units. All are said to function against positive pressure with no loss of capacity, and special modifications are available to fire against positive firebox pressures to ¾ in. WC. These burners incorporate a simplified design for easier servicing, a flame stabilizing combustion head, and large fan and motor providing ratings to 2,500,000 Btu input with no secondary auxiliary air required. All are automatic, and on the combination burner a flip of a switch changes from one fuel to another. Ray Oil Burner Co.

35—WATER HAMMER DEVICE for the small piping jobs

This water hammer eliminator, designed for small piping applications, is currently available with ½- and ¾-in. male IPT connections. From a design standpoint,



the unit takes advantage of the resiliency of seamless convoluted metal hose in combination with the compressibility of the air pocket. It is made of brass and bronze components and provided with an outer bronze braid covering for reinforcement. Resultant burst pressure of the unit is given as 900 psi minimum. The Techniflex Corp.

36—CONTROL VALVES for medium-duty applications

Series 400 Valves are reported to incorporate a number of engineering design improvements to provide improved flow characteristics for medium-duty valves. The line of diaphragm control valves includes double-seated, single-seated and three-way types for use in either "on-off" or proportional control systems. The "on-off" single seated model can be supplied with a plug having a soft composition disc which provides bubble-tight shutoff, company announces, and the three-way valve may be used for either diverting or mixing service. Component parts in the series are standardized. The compact design of these valves makes them suitable for installations in limited space areas. Valve Div., Minneapolis-Honeywell Regulator Co.

37—GEAR PUMP available with two to six outlets

This multiple outlet gear pump, the Model Z3U, may be had with two to six outlets. A divider device, controlled automatically, is designed to let each outlet deliver a measured quantity of lubri-

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Some outstanding features of General Cable's Varnished Cambric Cable are: resistance to oils, greases, the effects of corona discharge; high dielectric strength, long cable life, and high safe operating temperatures which permit larger current carrying capacities. General Cable's Varnished Cambric is available in single or multi-conductor types with outer coverings of braid, tape and braid, lead, neoprene or a variety of armors, including steel, bronze or aluminum. Interlocked Varnished Cambric Cable is ideal for wiring in close areas and under, down and around beams and pillars... where power needs vary... where plant layout presents space difficulties.

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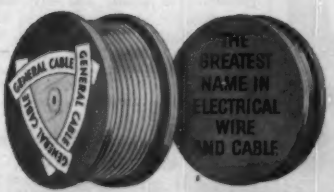

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Installation of C & D 60-PL-17 PlastiCell Control Batteries. Battery capacity: 440 A.H. Estimated life: more than 15 years.

Seattle City Light, one of the Pacific Northwest's largest utilities, joins the growing list of utilities and municipalities that have switched to C & D for an economical and dependable source of battery power. Once again, C & D leads the field with an important "first"—the *first* battery specifically designed for control, switchgear, and auxiliary power applications!

By replacing its old installation with C & D PlastiCell Control Batteries, this progressive utility saves 25% of valuable floor space for other purposes. C & D Batteries also provide these "more battery for the money" advantages—

1. Triple insulation—thick Fibreglas mat, microporous separators, and perforated Koroseal retainer.
2. Extra-long life—Exclusive design combines advantages of both suspended and supported plate construction.
3. Saftee-Vent—outstanding C & D development that prevents accidental battery explosions.
4. Crystal-clear plastic jars—heat resistant and hermetically sealed.
5. Plastite post seals—for easier maintenance.

for details . . . Write for new C & D Specification Bulletin: CP-537 (Rev. 1) on "PlastiCell Batteries." If you are interested in 25-year battery life—ask for Bulletin CP-536 (Rev. 1) on PlastiCal batteries.

C&D BATTERIES, INC.
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cant independent of prevailing counter pressure. According to company, the pump utilizes a single pair of gears to assure precision operation with minimum power consumption. Pumps come in different sizes, depending on amount of lubricant required; and delivery of outlets can be equal — or each can be designed for a different quantity. Model Z3U can also be supplied with reversible drive for operation in both directions.

This pump operates on a rotary drive with the direction of rotation controlled by an adjustable sleeve on the drive shaft. It is declared well suited to applications where several circuits of liquids or lubricants are required to work separately and independently of counter pressure. Uses include circulating lubrication of large diesel motors, gear reduction units. Nathan Mfg. Corp.

38—STEAM TRAP for 10 to 600 psi pressures

Newest addition to this manufacturer's Thermodynamic line of steam traps is the Type TD-50 for pressures from 10 to 600 psi, temperatures to 950 F. Like the other traps in the line, this one uses the thermodynamic energy of steam to close the valve. The trap is said to operate equally well on light or heavy loads, close tight on no load, and operate on back pressures up to 50 per cent of the inlet pressure.

Machined from stainless steel bar stock, this trap has only three parts: body, screwed cap and valve head — a solid stainless steel disc. Compact in size, this trap is 1¾ by 2⅛ by 2¾ in. Manufacturer claims there is practically no need for maintenance. Only operating part is the valve head. Because it is all stainless steel, this trap is said to resist both internal and external corrosion. It is also claimed unaffected by water or vibration, and to be freeze-proof when installed in a vertical line with open discharge line. It discharges at saturated steam temperature. Bulletin Supplement 255-44 gives data. Sarco Co., Inc.

39—MOTOR VALVE is bellows-equipped, all metal unit

For use with hydraulic and pneumatic control systems, the No. 992-D Bellows Motor Valve is reported to have outstanding modulating characteristics. Equipped with a cadmium-plated steel spring and two-ply seamless metal bellows, this valve is used to control the flow of steam, gas, oil, water and other fluids. It is used as a final control element in pneumatic and hydraulic systems to maintain pressure, temperature, or level in vats, tanks, and processes.

Announced as satisfactory for over 50 per cent of industrial applications where motor valves are used, the Series 992-D possesses a linear valve movement and is available in sizes from ¼ to 4 in. and in a variety of valve types, in direct or reverse acting styles. Fulton Sylphon Div., Robertshaw-Fulton Controls Co.

To get more product information use the Reader Service Cards on pages 118–119. You may also use them to ask for data on advertised products.

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P.P.&E.'s modern gas-fired furnace, illustrated above, is a specially-developed design. Time-temperature conditions can be electronically controlled in it for proper heat treatment of each type of metal.

This heat treating procedure is assurance that piping fabricated by P.P.&E. will have the most desirable combination of ductility, toughness, impact resistance, and strength.

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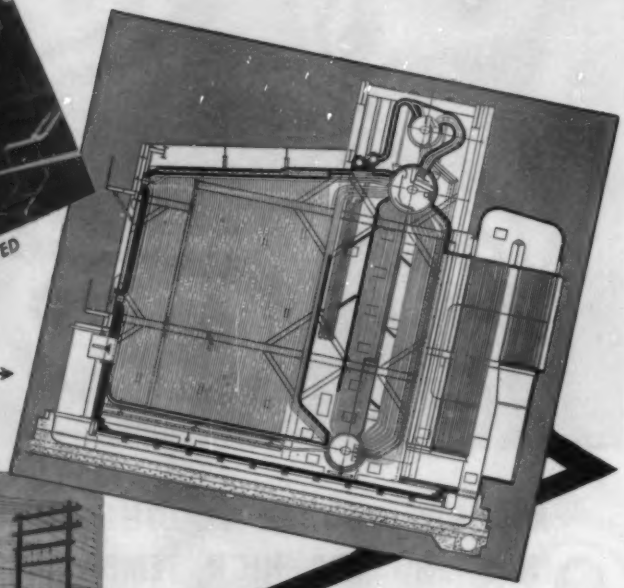

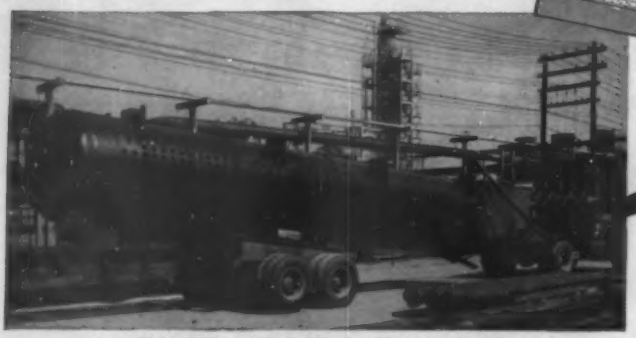

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MAN-MADE ROCK CHANNEL FOR MORE KILOWATTS

An outstanding feature of Virginia Electric and Power Company's new hydro development at Roanoke Rapids, North Carolina, is the tailrace. Blasted through solid rock for a distance of 8,000 feet, to an average depth of 45 feet and a width of 80, it is one of the largest man-made rock cuts for power purposes ever completed in this country.

Another feature of the station is the powerhouse foundation, which was excavated through rock to a depth of 72 feet.

The concrete dam is 3,050 feet long, and provides a maximum net head of 81 feet.

Four adjustable blade propeller type turbines in the semi-outdoor powerhouse add 100,000 kilowatts to the VEPCO system.

View from above dam at Roanoke Rapids Power Station. The project, which will serve the fast-growing Virginia-North Carolina industrial area, requires a reservoir nearly 9 miles long, with a surface of 4,900 acres. Construction was by Stone & Webster Engineering Corporation.

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Write or call us for information as to how our experience may be of assistance to you.

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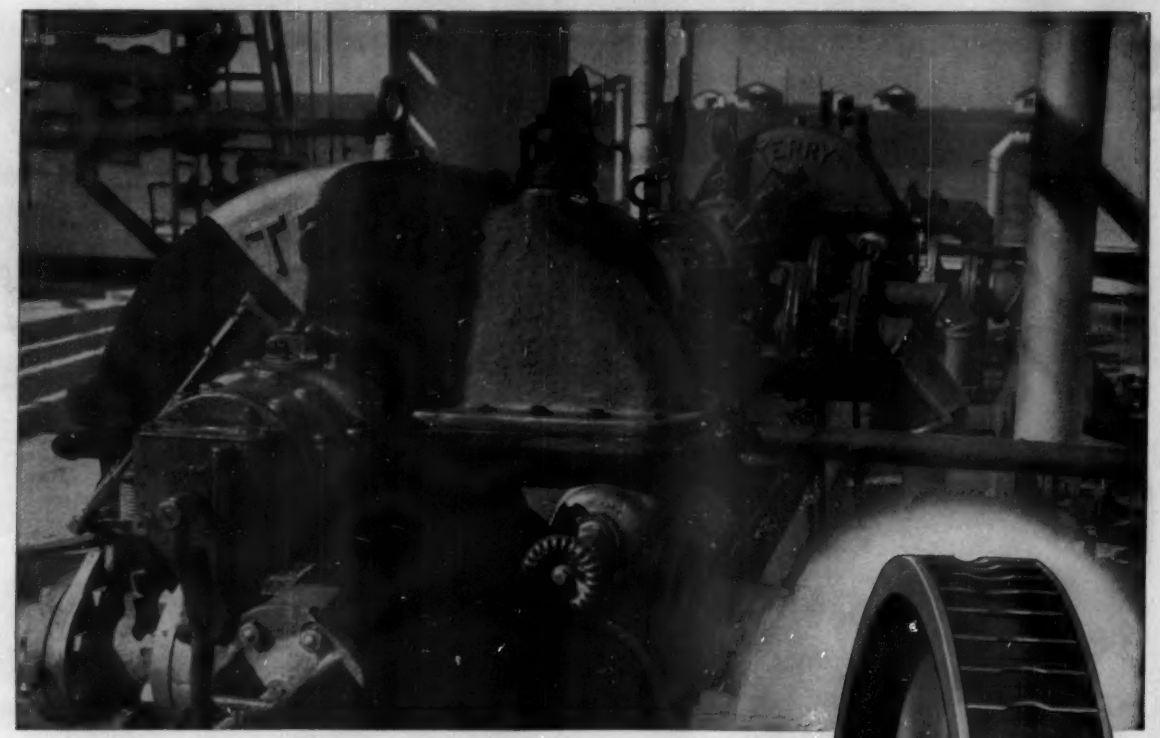

Two Terry Turbines equipped with "trouble eliminators"

Because these turbines have solid wheels, they can take a lot of abuse, without complaint. Here's why:

1. The wheel has no separate parts to become loose or work out. It is a single forging, in which a series of semi-circular buckets is milled.

2. Blade wear is of little consequence because the power-producing action of the steam takes place on the curved surfaces at the back of the buckets. Wear does not materially affect horsepower or efficiency.

3. The blades cannot foul. There is a one inch clearance on either side of the wheel and, in addition, the blades are double rim protected. There is no need for close axial blade clearance, because the steam enters the buckets in a direction at right angles to the shaft.

For complete details of these *work horses of industry*, send for a copy of bulletin S-116. No cost or obligation.

THE TERRY STEAM TURBINE CO.

TERRY SQUARE, HARTFORD 1, CONN.

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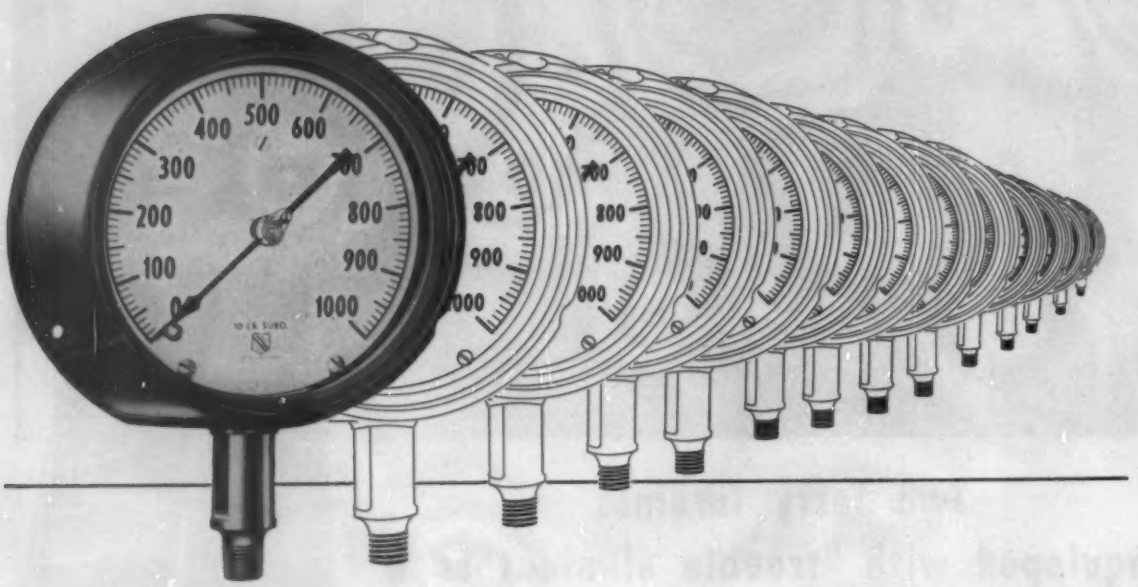

Service Conditions primarily determine the pressure gauge you specify for your installation. The wrong gauge can cost time, trouble, and money.

That's the big reason why Ashcroft Duragauges make sure of your complete satisfaction by offering a multiple choice in case designs and materials, Bourdon tube materials, ranges, movements, and dial sizes. Briefly, you can select the right gauge for your requirements from:

Cases of 3 different materials in 8 service-proved designs.

Bourdon Tubes of 8 different types of metals to meet specific service requirements.

Pressure Ranges from 30" vacuum or a few ounces through 100,000 psi.

Rotary Geared Movements that include the famous "Nylon Movement" or all stainless steel.

Dial Sizes from 4½" through 12".

Most important, Ashcroft Duragauges provide that unbeatable combination of highest sustained accuracy and durability of any pressure gauge built.

TAKE ADVANTAGE of the counsel of your nearby Industrial Supply Distributor. You can count on him to help you select Ashcroft Duragauges that will serve better and longer, with minimum maintenance, no matter how severe the conditions of vibration, pulsation, corrosion and weather.

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MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

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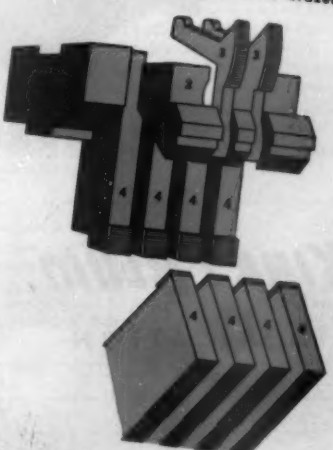
G-E Type AK-1-50 Electrically Operated Air Circuit Breaker, 1600-amperes, 600 Volts, A-C. One pole shown. Made by General Electric Company, Low Voltage Switchgear Department, 6901 Elmwood Ave., Philadelphia, Pa.

Here is the General Electric Type AK-1-50 Electrically Operated Air Circuit Breaker, 1600-ampere frame size used to protect low-voltage systems. The picture shows one pole of the contact, and in order to photograph it, the housing and the arc-quencher parts were removed. Note the Revere Extruded Shapes, and Rectangular Rod. There are three shapes, and one size of bar, all in copper, because copper has the highest electrical conductivity of all commercial metals.

If these shapes had to be "hogged" out of bar, they would be expensive, due to the machining time, and the scrap generated. While copper scrap is readily salable at good prices, it is costly from the machining standpoint. Extruded shapes by Revere, preformed to the desired contours, usually reduce machining to a cutting-off operation, plus such minor details as drilling which cannot be done during extrusion. Shapes naturally cost more per pound than bar or rod, but the ultimate saving makes up for the difference and more, sometimes several times.

Are you doing much machining of copper? If so, look into Revere Extruded Shapes. They may save money, and speed up production as well. See the nearest Revere Sales Office.

Sketch showing details of contacts. Nos. 1, 2 and 3 are extruded and drawn copper shapes. No. 4 is rectangular copper bar. Cross hatching represents special arcing contacts brazed to the copper.



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Whatever your requirements in fabricated plate, sheet or structurals for power plant use . . . call on experts!

Kirk & Blum has fabricated a variety of power plant needs as big as the mammoth breeching section shown here. In a 150,000 sq. ft. plant, with crane capacity to 25 tons, Kirk & Blum has complete facilities to produce, pre-assemble and load the largest fabrication. Kirk & Blum has the men, materials and experience to do the job quickly and economically.

For detailed literature, write: The Kirk & Blum Mfg. Co.
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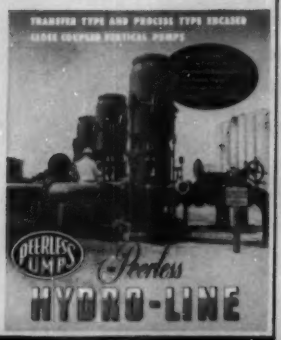
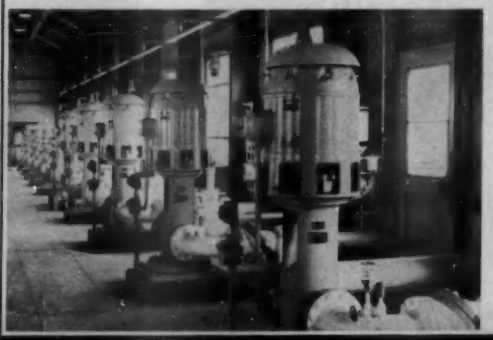
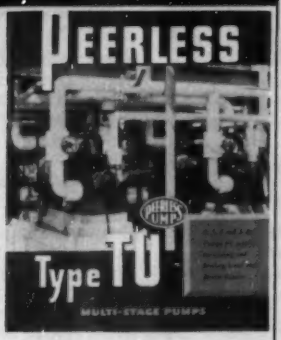
either way YOU LOOK AT THE PUMPING PROBLEM





VERTICAL

Horizontal



PERFORMANCE-PROVED PEERLESS PUMPS WILL DO THE JOB BETTER

Here's why—You can choose from either Peerless vertical or Peerless horizontal designs for most every liquid transfer job—water or process liquids. You can select the pump you need from the broadest range of heads, capacities and horsepowers.

You can buy and apply a Peerless pump with the confidence that it will provide dependability over the years.

Bulletin B-1700, at the top above, describes Peerless vertical can type process pumps. Bulletin B-1400 just above describes multi-stage horizontal pumps for high pressure liquid transfer.

Write for your copies. You'll find out how Peerless pumps can squarely meet your pumping needs with economy, efficiency and dependability.

PEERLESS PUMPS

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STARTLING NEW FACTS ON EXPANSION JOINT MAINTENANCE

It may cost less than you think to service expansion joints. Look at these records from three typical users of Yarway Gun-Pakt Expansion Joints:

To add packing to a Yarway Gun-Pakt joint, just insert a slug and twist a wrench; the joint is tight, the job done. There is no unpacking operation.

	YARWAY GUN-PAKT JOINTS	CONVENTIONAL GLAND-PACKED JOINTS
STATE UNIVERSITY*	Required addition of only 3 slugs (45 cents) of packing in 5 years. Lubrication only once every 6 months. Total labor time of only 2 manhours in 5 years.	Same lubrication as Gun-Pakt, *plus* gland tightening, *plus* complete overhaul with shutdown for unpacking and repacking every 3 to 4 years. Time for overhaul—25 manhours per joint!
MID-WEST AIRFIELD*	Only maintenance was lubrication and addition of 2 slugs (30 cents) of packing per year. Total labor ¼ manhour per joint per year.	Lubrication and gland tightening required 8 manhours per joint per year—plus complete unpacking and overhaul every 2 to 3 years. Time required for overhaul—20 manhours per joint.
"BIG TEN" UNIVERSITY*	Lubrication only once every 2 months, with packing added as needed. Total labor time charged, 1 manhour per joint per year.	General maintenance requires 6 manhours per joint per year. Complete overhaul required every 2 to 3 years with unpacking and repacking—24 manhours per joint.

*Names on request.

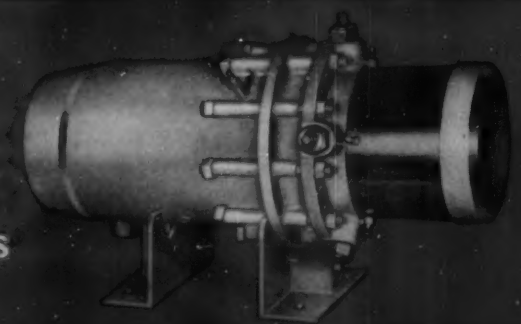
To get the full facts on Yarway Gun-Pakt Expansion Joints, and how they can save you maintenance money, write for Yarway Bulletin EJ-1913.

YARNALL-WARING COMPANY
108 Mermaid Ave., Philadelphia 18, Pa.

YARWAY

gun-pakt expansion joints

Yarway single-end, welding type Gun-Pakt joint for pressures to 300 psi, heavier design for higher pressures. Single-end traverses up to 12 inches; double-end up to 24 inches.



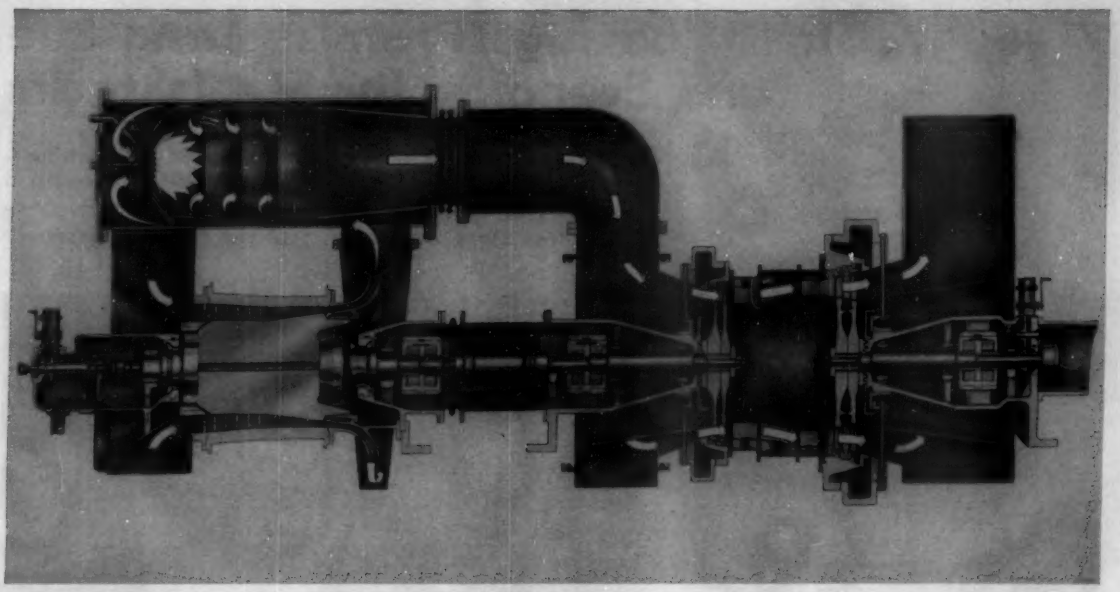


Fig. 1. Schematic of new 5500-kw, two-shaft gas turbine for mobile emergency operation. Safety valve is not shown here

Mobile Gas Turbine Puts 5.5 MW on Rails for Disaster Power or Load Relief

Here is a one-car power train that needs only a load, a fuel supply, and a bad situation to go into business. Overall efficiency is only 19 per cent (space eliminates regeneration), but it gives "where" as well as "per cent" meaning to the term "availability"

NINETEEN per cent breaks no efficiency records even for simple-cycle gas turbines, but 5500 kw of emergency power in one package does, to the best of our knowledge. Auxiliaries, controls, auxiliary engine-driven generator (and a starter), station switchgear, and oil storage are all compacted nicely into one rail car being built for the U. S. Navy for use on standard AAR gage tracks. Limited fuel storage adds to its versatility, but steady operation requires additional supply.

Very new on the scene, this Clark mobile unit will go for a hair over $170 per kw, including the rail car. In this case, 5500 kw will go for something just over $1,000,000. Larger units are being considered, as are stationary counterparts. In the latter case, it would be possible to add regeneration and boost the efficiency nearly 10 per cent.

Basically, the new unit consists of a compressor section with its own 4800-rpm turbine and a separate 3600-rpm turbine to drive a direct-connected two-pole generator. Gas entry into the first turbine is at 50 psig and 1350 F. The second turbine receives gas at 15 psig and exhausts at atmospheric pressure and about 800 F. Operation of the second turbine at 3600 rpm permits elimination of the traditional gear box.

Protection against overspeed due to sudden load loss is afforded by a safety valve located between the two turbines. Should the circuit breakers throw off the load, this valve will instantaneously vent the excess gas.

Starting and operation has been made easy by automatic controls, so one man of average skill can put it on the line. A 159-hp starting diesel automatically cuts out when the unit reaches self-sustaining speed. This same diesel, driving a 50-kva 60-cycle generator, can supply the mobile station with all its power requirements when the main generator is not running.

No insulation is applied to the outside of this machine. An ingenious distribution of cooling air throughout keeps the maximum surface temperature at about 200 F. This cooling means *no changes of the combustion chamber liners for the life of the turbine*, and it guards against stresses resulting from hot spots found under lagging in conventional machines. These features add up to top-notch design.

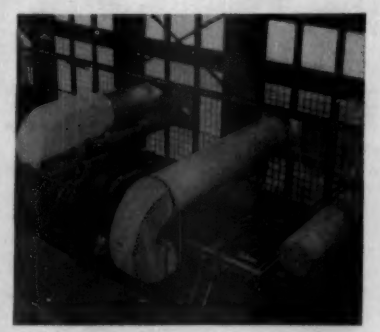


Fig. 2. Unit on test in rail car "template." No vibration was observed in the machine. White ducts are test gear

IF YOU WANT more information on this mobile power plant, write to the Editor, POWER ENGINEERING on your company letterhead. To get tear sheets of the article, jot "Mobile Turbine" on the postcard elsewhere in this month's issue

Tough Glass Coatings Promise Long Life and Economy for Steel Stacks

Glass is supposed to be brittle and entirely immune to acid attack. Like most of the truisms, this is true only in certain conditions and for certain types of glass. These new stacks use special corrosion-resistant glass that's extremely tough to insure long service

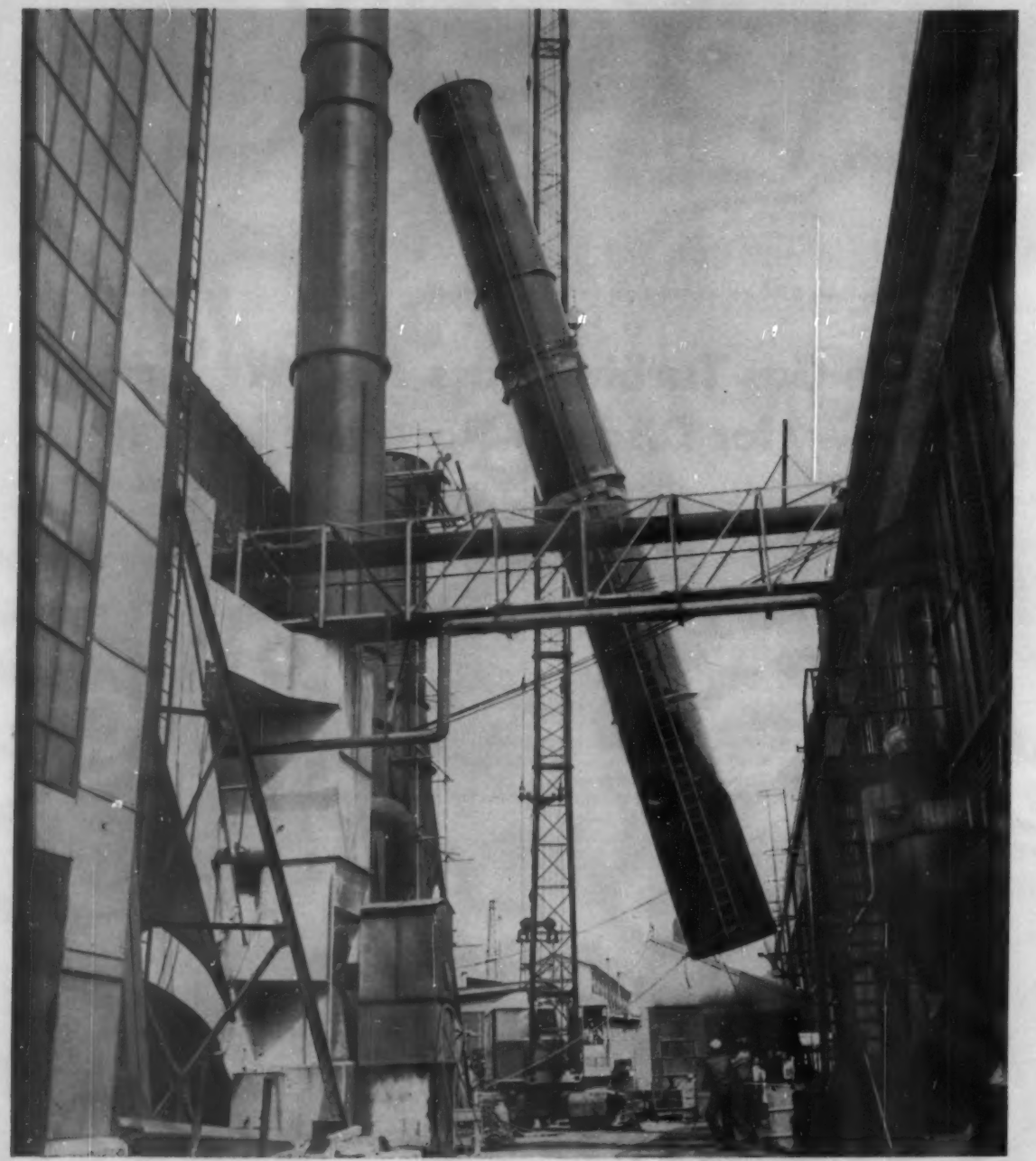


Fig. 1. A. O. Smith's second glass-coated stack goes up. The only precautions taken during erection were the pads under each sling, and the crews for each job had no previous experience with glass-coatings. Left stack went up in '53

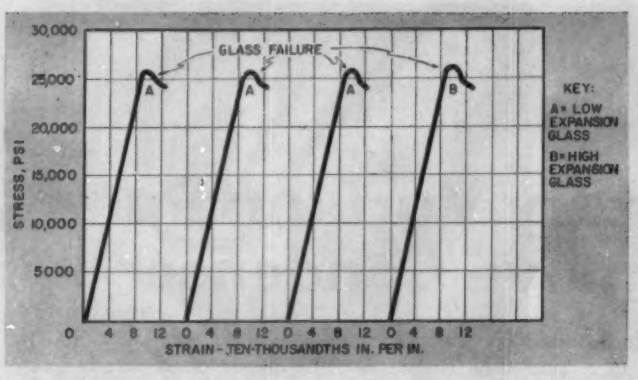


Fig. 2. Stress-strain diagram for enameling iron coated with glass. Note that the glass fails beyond the metal's yield point in each case

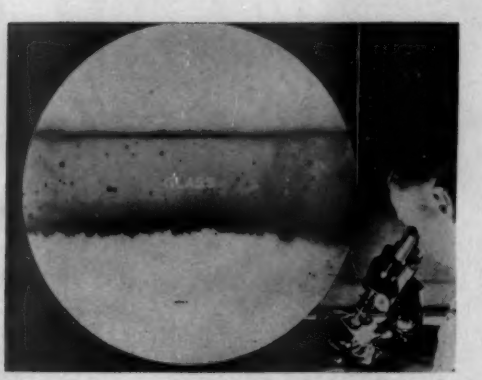


Fig. 3. A 64-diameter magnification of glass bonded to steel at 1600 F. The bond will not separate

THOUGH MUCH has been said and written recently about glass- and ceramic-coated air heaters, very little has been mentioned about glass-coated smokestacks which can handle flue gases below their dew points. The two developments should go hand-in-hand. Fortunately, the lack of publicity indicates only a careful and methodical evaluation — not a lack of development.

Glass-lined smokestacks have been on test for nearly two years and are just now being marketed. Such stacks are made of a mild steel with two coats of fused glass. The coat adjacent the steel bonds especially well to metal, while the outer coat is especially resistant to corrosion by acids. A 20-month test recently completed showed a loss of surface gloss to be the only effect of exposure to a highly corrosive flue gas for this full period.

Not all glasses fare as well when put to this test. One so-called "light-duty" glass and one commercial glass coating were badly etched during this test, while three different acid-resistant coats and the base coat stood up as previously noted. Should small pinholes occur in the acid-resistant coat, the additional protection of the base coat stands between corrosive condensations and the steel.

It is not claimed by the developers of these stacks that they will last forever, merely that they will last much longer than steel stacks without glass protection. Specifically, a life of 25 years (as compared with 10 to 12 years) is forecast, and is considered conservative. Conventional stacks vary greatly in their length of service, but it is reasonable to assume that an installation which yields longer service for conventional stacks would yield a much longer service for glass-coated stacks.

There is more to be considered than length of service, however. Corrosion protection of this calibre permits the elimination of that extra margin of steel provided in unlined stacks expressly to allow for corrosion. Where plate thicknesses of ¼ in. are required for structural reasons, it is customary to allow another ⅛-in. of steel which can be eaten away before the stack becomes unsafe.

Many steel stacks subjected to corrosive duty are lined with brick, and the steel plates must be heavy enough to support the brick as well as their own weight. It is not customary to allow extra metal for corrosion where linings are used, but much extra structural strength is needed — thus eliminating the saving. Compare the weight of five inches of brick in a conventional lining with the 0.012-in. (± 0.002-in.) coat of glass. It should be obvious that weight savings of this magnitude will affect the requirements for foundations and for structural steel supports, where stacks are mounted on boilers or buildings.

Regarding the last point, it might appear that this would be pertinent only where the reduced structural requirements could be accommodated in new designs. It presents another possibility, however; stack replacements with the lighter stacks can be taller than the conventional stacks they replace, without increasing the investments in supports. Plants faced with ultimatums from air pollution groups could make good use of this characteristic to discharge their gases higher, possibly going to a smaller-diameter stack with higher velocities at the same time. The smaller stack diameter would, of course, permit an even greater increase in height if proper guying is practiced.

This leads us to another consideration. How high can a glass-coated stack be made before its own weight leads to base loading to such an extent that the glass fails? What about the natural sway of the stack? Would this cause glass failure?

Tests conducted on this type material indicate that glass failure occurs after the deformation stress of the metal is reached. Since any structural use of metal calls for stresses well below those at deformation, we have reason to believe that the exercise of elementary design practice is all that is required to avoid such stress-failures of the glass coat. The glass, in other words, is tough.

The possibility of damage to the stack during erection has troubled many engineers interested in the development. While this could happen, two such stacks (one 44 and the other 75 ft.) have been erected without mishap by millwrighting firms without previous experience in their handling. Their only precaution was the use of padded slings. Indeed, the possibility of damage to surrounding facilities is such that careless practice in erecting glass-coated *or* conventional stacks does not perpetuate itself.

Glass-coated steel can be drilled and cut much as other steel. Should some small boy try out his new rifle on the stack, it is possible to flame-cut out the affected area and bolt on a coated patch. Holes may be drilled also for attaching ladders and other hardware. Special bolts with glass-coated heads extend the protection of glass throughout the stack and could be used to patch holes small enough to be covered by their heads.

Until research devises some way for welding sections together without damaging the glass, stacks will be supplied in flanged sections and will be bolted together. High-temperature plastic coatings protect the exposed parts of fasteners, such as the bolt threads, from atmospheric corrosion. The manufacturer's present plans call for the production of sections up to 20 ft. long, and 36- to 84-in. in diameter.

Selection of a glass-coated stack would mean paying about 50 per cent more than for a conventional unlined stack, but conservative estimates predict a 100 per cent increase in life.

For more complete information on this money-saver, write to the Editor, POWER ENGINEERING, 110 S. Dearborn St., Chicago 3, Ill.

Rotary Vacuum Pumps Remove Condenser Air

To eliminate need for auxiliary steam in their new stations, Public Service Elec. and Gas Co. of N. J. have replaced steam ejectors with rotary vacuum pumps. They are proving very successful indeed

By R. I. SMITH*

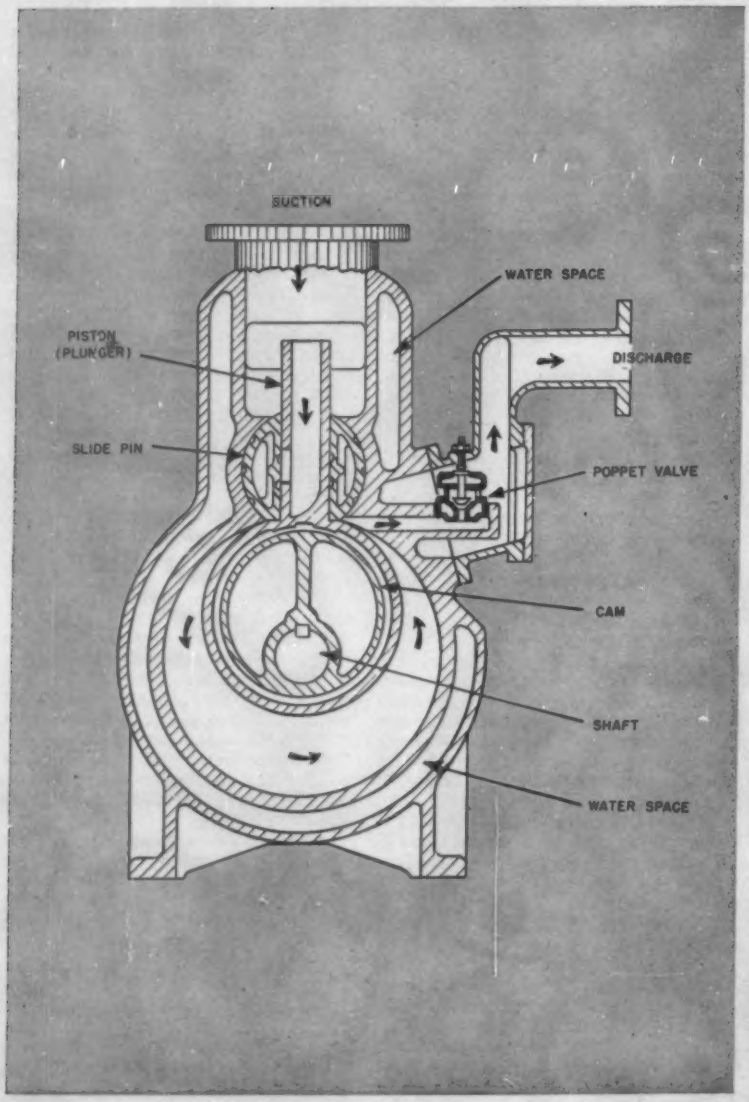


Fig. 1. Cross-section of Kinney rotary plunger type vacuum pump described in text

ALL STEAM auxiliaries have been eliminated from Public Service Electric and Gas Company Turbine-Generator Units installed since 1943. One of the most interesting problems in the development of this design was the substitution of a motor-driven pump for the steam jet ejector normally used for condenser air removal. A positive displacement, rotary plunger type vacuum pump, made by the Kinney Manufacturing Company (now the Kinney Manufacturing Division of The New York Air Brake Company), was selected for this service. Operating experience over the past ten years has shown this equipment to be a thoroughly satisfactory substitute for the steam jet ejector.

The desire to eliminate steam auxiliaries originated with the design trend toward higher steam pressures and temperatures with unit systems and centralized control. If auxiliary steam is required for starting a unit, expensive pressure reducing equipment must be installed so that this steam can be taken from the boiler. Moreover, the exacting feedwater purity requirements of high-pressure, high-temperature unit systems dictate minimum make-up to reduce the possibility of contamination from the make-up system.

In addition to eliminating the need for auxiliary steam, the vacuum pump has these further advantages over the steam jet ejector which make it attractive to utility plant designers:

1. High air capacity at low vacuum, eliminating the need for starting evactors and providing an inherent ability to handle large air leaks in an emergency.
2. Ready adaptability to remote push-button starting and stopping.
3. More complete removal of corro-

*Assistant to Mechanical Engineer, Electrical Engineering Department, Public Service Electric and Gas Company (New Jersey)

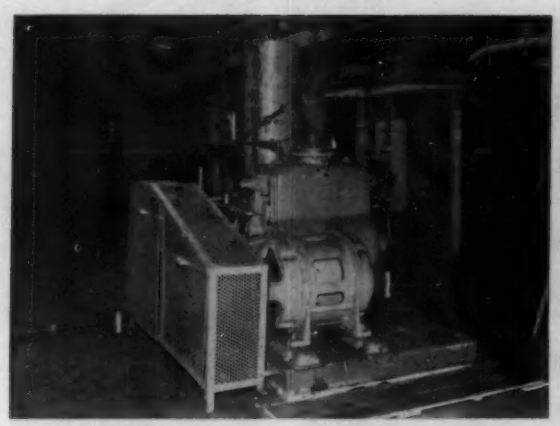


Fig. 2. Test installation of vacuum pump at Marion Gen Stn

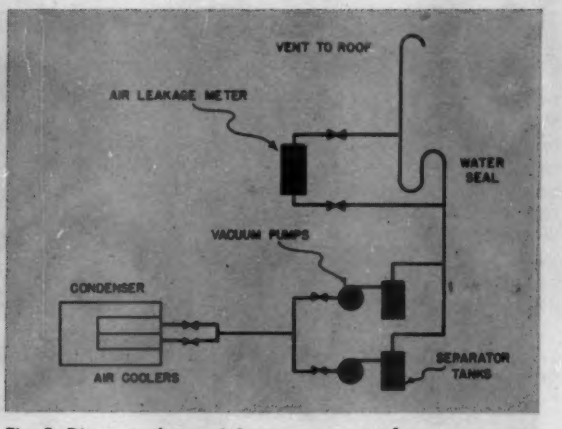


Fig. 3. Diagram shows piping arrangement for vacuum pump

sive gases from the system (or a reduction in make-up requirements if the steam jet condenser drains must be wasted to prevent contamination).

In 1945, during the development of the design for No. 1 Unit at Essex Generating Station, a Kinney DVD 18 x 14 x 20 vacuum pump was borrowed from a lamp manufacturer and temporarily installed on the 55,000 sq ft condenser of an operating unit at Marion Generating Station. (See Fig. 2). Prior to that time, experience with this type of pump in the Public Service system was limited to small units installed on mercury vapor condensers and generator hydrogen cooling systems. Tests were conducted on the pump installed at Marion during the latter part of 1945 and early 1946. Upon the satisfactory completion of these tests, two pumps of the size tested were ordered for Essex, and since that time, fourteen additional pumps have been installed in the Public Service system, making a total of sixteen such units, as listed in Table I.

Other Rotary Pumps

During the period of original study in 1945 and since that time, consideration has been given to rotary vacuum pumps other than the Kinney. The Beach-Russ Company manufactures a sliding gate pump which appears to meet the requirements for condenser air removal service. The F. J. Stokes Machine Company makes a vacuum pump which is similar to the Kinney in design. More recently, the Allis-Chalmers Manufacturing Company has entered this field with a sliding vane type vacuum pump which was designed specifically for condenser air removal. Little consideration has been given to reciprocating vacuum pumps because of a basic desire for rotating machinery.

The Kinney vacuum pump is a simple, rugged piece of equipment consisting essentially of only three moving parts. (See Fig. 1). An eccentric cam is keyed to the pump shaft which rotates the piston or plunger. The plunger has an integrally cast hollow arm which moves in a slide pin. As the plunger rotates, air is admitted to the cylinder through slots in the plunger arm. These slots are closed by the slide pin at the top of the stroke, and air is discharged through spring-loaded poppet valves as the plunger continues its rotation. An oil separator tank, connected to the pump discharge, provides a storage space for the oil used in sealing and lubricating the working parts as well as a separating chamber for the oil and air mixture discharged by the pump. The DVD pump has a center division wall and two sets of parts operating off the same shaft with the two cams 180 degrees apart.

A vacuum pump operating at 400 rpm has a theoretical displacement of 780 cfm, and its volumetric efficiency is such that at normal condenser vacua (1 to 2 in. Hg), this capacity is reduced to 600 cfm. The condenser air leakage which one of these pumps will handle, in terms of dry air at 70 F and atmospheric pressure, is dependent upon the partial pressure of the air in the air and vapor mixture handled by the pump. The performance of the condenser air cooler section, therefore, determines the amount of air which the pump will handle before the condenser vacuum is affected. For example, if a pump is operating on a condenser with a pump suction pressure of 1-in. absolute, and the condenser air cooler section has cooled the air and vapor mixture 7½ deg below the saturation temperature corresponding to 1-inch Hg, the pump is capable of handling 4½ cfm of air leakage. If the mixture is cooled 15 F below the saturation temperature under the same operating conditions, the pump capacity is automatically raised to 8 cfm.

Two vacuum pumps with 40 hp motor drivers have been installed on each unit in an arrangement similar to that shown in Fig. 3. Each pump takes its suction from the condenser air off-take header and discharges through its separator tank to the roof via a common discharge header. A water seal in the discharge line forces the air through a limited capacity rotameter which is mounted in or adjacent to the central control room. During starting periods or periods of high air leakage, the air blows through this seal to prevent back-pressure in the discharge line. The vacuum pumps are started and stopped from the central control room where ammeters showing the driving motor amperes are located. All valves in the system are normally left open so that no local attention is required to start a pump.

The air leakage of a modern, welded steel shell condenser should

Table 1. Public Service Co. stations using rotary vacuum pumps for condenser air

Station	Unit No.	Unit Size mw	Cond sq ft Surface	Number of Vacuum Pumps	Service Date
Essex	1	110	55,000	2	1947
Sewaren	1	110	50,000	2	1948
Sewaren	2	110	60,000	2	1948
Sewaren	3	110	60,000	2	1949
Sewaren	4	125	65,000	2	1951
Kearny	7	145	70,000	2	1953
Kearny	8	145	70,000	2	1953
Burlington	7	185	80,000	2	1955*

* Not yet in operation

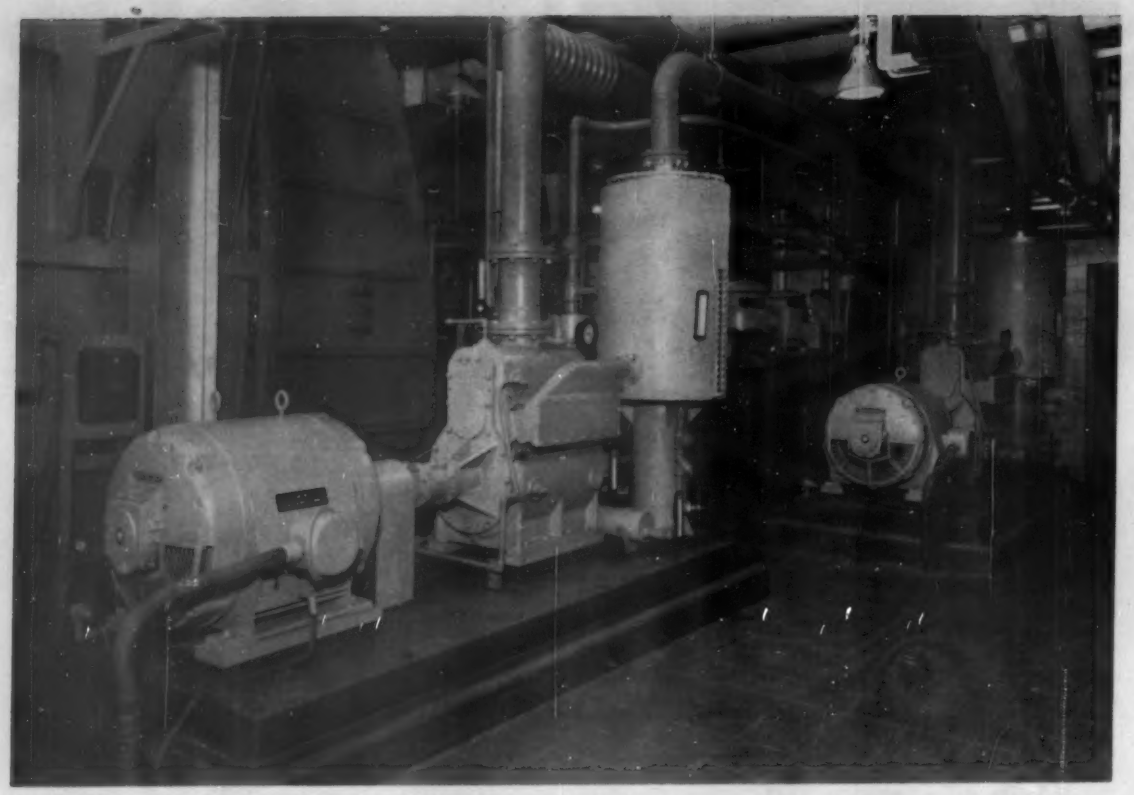


Fig. 4. Vacuum pumps of latest design at Kearny Generating Station. Performance of pumps has been completely satisfactory

not be greater than 3 or 4 cfm, and a single pump is considered to have sufficient capacity under normal operating conditions. The second pump is put in service during periods of high air leakage if any improvement in condenser vacuum results from its operation. Two pumps are used when starting a unit to reduce the time required to pump down the system. Tests conducted on the unit at Essex showed that the use of two pumps rather than one reduced the time required to obtain approximately 20 in. Hg vacuum in the condenser from 40 minutes to 25 minutes.

To properly seal the pump, a lubricant having a viscosity of approximately 100 SSU at the operating temperature is required. The Essex pumps and the first pumps installed at Sewaren used Lindol (tricresyl phosphate), a product manufactured by the Celanese Chemical Corp., as the sealing and lubricating medium. The preliminary tests conducted at Marion indicated some difficulty with emulsification of the sealing oil. Lindol, a clear transparent liquid having a specific gravity of 1.17, was chosen because of its excellent water separating qualities. The fact that it is heavier than water allowed the oil system to be designed so that excess water floated off the top of the mixture in the pump separator tank. A water overflow tank was installed to serve as a trap for collecting oil and water from the pump discharge system, and any oil collected can be reclaimed from this tank. With the installation of vacuum pumps on No. 3 Unit at Sewaren, the sealing and lubricating system was redesigned to operate with a heavy petroleum oil. Temperature at the vacuum pump discharge and in the pump separator tank is maintained sufficiently high (220 F) to keep the water discharged by the pump in the vapor state and so prevent emulsification. At the present time, all pumps are operating with the heavy petroleum oil.

Because of the eccentric rotating motion of the pump, care must be taken to provide a firm foundation of sufficient mass to prevent vibration. At Essex, for example, the pumps were originally mounted on a platform above the condenser floor, and vibration was excessive until additional bracing was installed. These pumps have recently been relocated to the floor below where adequate foundations were installed for them.

The pumps at Kearny (See Fig. 4) represent the latest design and include a number of features not found in the original pumps furnished for Essex. A direct drive, 400 rpm motor has been substituted for the 1200 rpm motor with a V-belt drive. A forced feed lubrication system with the oil pump mounted on the main pump shaft has replaced the gravity feed system with a solenoid valve in the oil line between the separator tank and the vacuum pump. A mechanical seal has been installed to replace the shaft packing and the pump, driving motor, separator tank, and overflow tank have been arranged as a unit on a common baseplate.

All of the vacuum pumps have operated since their installation with very little maintenance. The spring-loaded poppet valves are checked periodically and occasional replacements are made. Oil leakage, which was a problem with some of the earlier pumps, has been eliminated through the use of the mechanical seal and welded piping in place of the screwed piping originally furnished. Several cast iron pump discharge nozzles failed in service, and the manufacturer replaced them with cast steel nozzles, which have since become standard. Inspections of the pump internals have shown no appreciable wear, and the only replacement of a plunger on record was due to a failure resulting from an attempt by the pump to handle a ¾-in. nut. Strainers are normally installed at the vacuum pump inlets to prevent damage to the equipment during preliminary operation.

In general, the performance of the pumps has been completely satisfactory and plans for future turbine generator units include the use of similar pumps to replace ejectors.

Fig. 1. Submarine hull section and water tank surrounding reactor section of hull shown inside the huge steel sphere at West Milton, where prototype reactor for Navy submarine *Seawolf* is being tested. Steam from this reactor is being used to generate commercial electricity

First Commercial Atomic Power Produced by G-E

THE FIRST atomic electric power for commercial use was generated by the General Electric Company and sent into the transmission system of the Niagara Mohawk Power Corp. on July 18. At an impressive ceremony marking this event, Chairman Lewis L. Strauss of the Atomic Energy Commission threw the switch which sent the atomically produced current into the Niagara-Mohawk system.

Peacetime Atomic Energy

In producing this atomic electric power, steam from the prototype submarine reactor built by General Electric at West Milton, N. Y. is piped to a 12,500-kw G-E turbine-generator. Francis K. McCune, G-E vice-president and general manager of G-E's Atomic Products Division said that power is being generated by G-E at no expense to the Government as a means of demonstrating the peacetime use of atomic energy. Cost of the General Electric portion of the power plant was about $1,250,000.

Besides Lewis Strauss, other notable speakers at the opening ceremonies on July 18 were Senator Clinton P. Anderson, Chairman of the Joint Congressional Committee on Atomic Energy, The Hon. Douglas McKay, Secretary of the Interior, and Ralph J. Cordiner, President of the General Electric Company.

The arrangement under which the power will be marketed by Niagara-Mohawk is temporary, pending determination whether any or all of three public service companies within a hundred-mile radius of West Milton, which have expressed interest in purchasing the power, can arrange for transmission to their systems. A price of 3 mills per kilowatt-hour for this was established by the AEC.

Inside of a 225-ft steel sphere the prototype nuclear reactor produces heat that is transferred to a heat exchanger by means of liquid sodium. The liquid sodium circulates through the heat exchanger where water is converted into steam to drive the turbine. At West Milton, a portion of this steam is used to operate the generator, which it is expected will operate at a level of around 10,000 kw.

Mr. McCune said that the General Electric Co. will derive no profit from either the conversion of nuclear power to electric power or from its distribution. Any such income, he explained, will go directly to the Government. He pointed out that although G-E is not in the power producing business, its operation of this equipment at its own expense constitutes another important step in a long series of atomic studies the company has had in progress over a period of years.

The prototype reactor for the *Seawolf* went "critical" for the first time on March 20 of this year. And just two months ago its first useful power turned its own turbines and propeller shaft. This reactor, of course, was not built to serve as a commercial power plant. It was built as an experimental unit to provide design information and to develop operating techniques for its sister plant to be installed on the *Seawolf*. Since it was built, however, and since it could produce heat and power, application was made to the AEC to use it in connection with a standard turbine-generator to produce power for sale to utility companies.

Power Available

The capabilities of the *Seawolf* and the amount of power at her command are, of course, secret but the fact that only a portion of the steam generated in the reactor is capable of generating at least 10,000 kw gives some idea of the power available on the submarine itself.

Installation of the turbine-generator and allied equipment required only 17 days. Installation was done by the Bechtel Corporation under the direction of the G-E Real Estate and Construction Services Department.

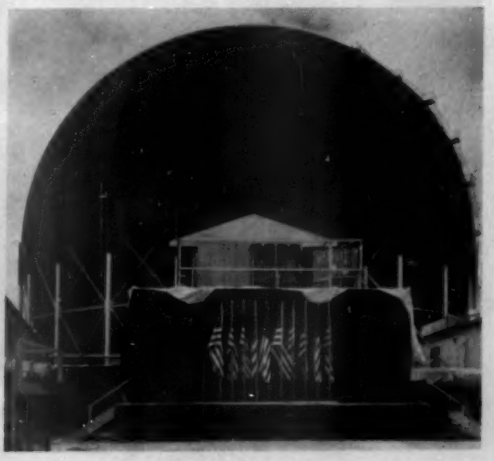
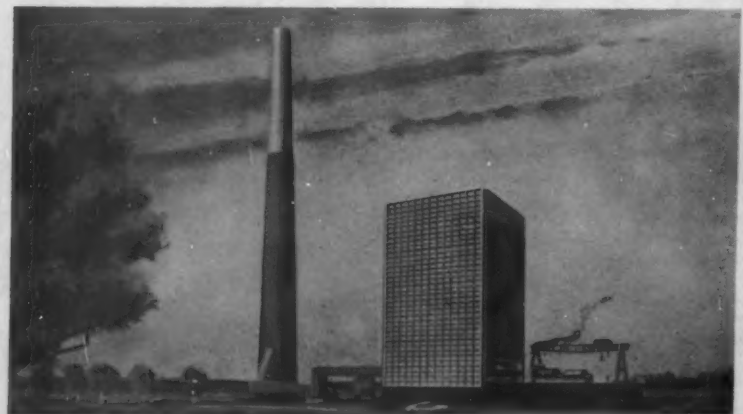


Fig. 2. The turbine-generator producing the electric power is behind the speakers stand used during the opening ceremonies on July 18. The huge steel sphere housing the prototype reactor for the *Seawolf* is shown in background

News Reel

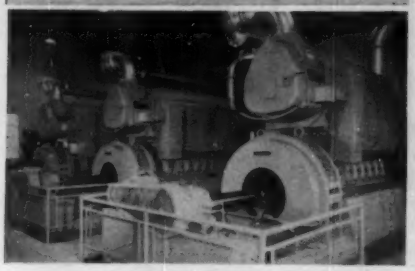
Cmdr. Wm. Tessin, Navy BuShips (foreground, left), and R. A. Budenholzer, Chairman of American Power Conference, IIT (right), inspect specimens on famous Kure Beach, N. C., test racks at recent International Nickel Co. corrosion conference

Going down under down under. World's tunneling record being set by U. S. contractors on Australian hydro project



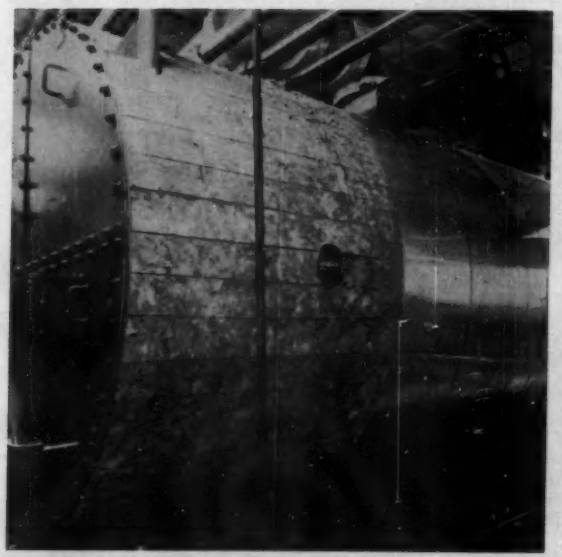
Designed to be "the best-looking electric generating plant in America," this architect's impression shows proposed plant of the Connecticut Light & Power Co.

At June ASME Oil and Gas Power Exhibit, Washington, W. T. Humphreys shows F-M "talking" diesel model to R. C. Hagenmiller of POWER ENGINEERING staff

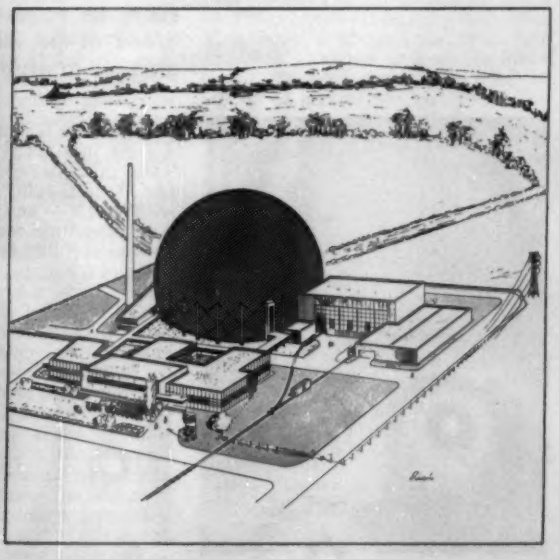


Fairbanks-Morse diesel units give steady volts and frequency for guided missile control at Florida test center

200,000 kw on one railcar! Westinghouse generator for Philadelphia Elec. Co.'s Cromby station shows striking increase in output per lb with "inner cooling"



New technique for insulating boilers gives neat, fast job. 2-in. blocks of Fiberglas are covered with aluminum sheath



Commonwealth Edison's proposed nuclear power plant for Chicago area. Capacity 180,000 kw. Scheduled for 1960

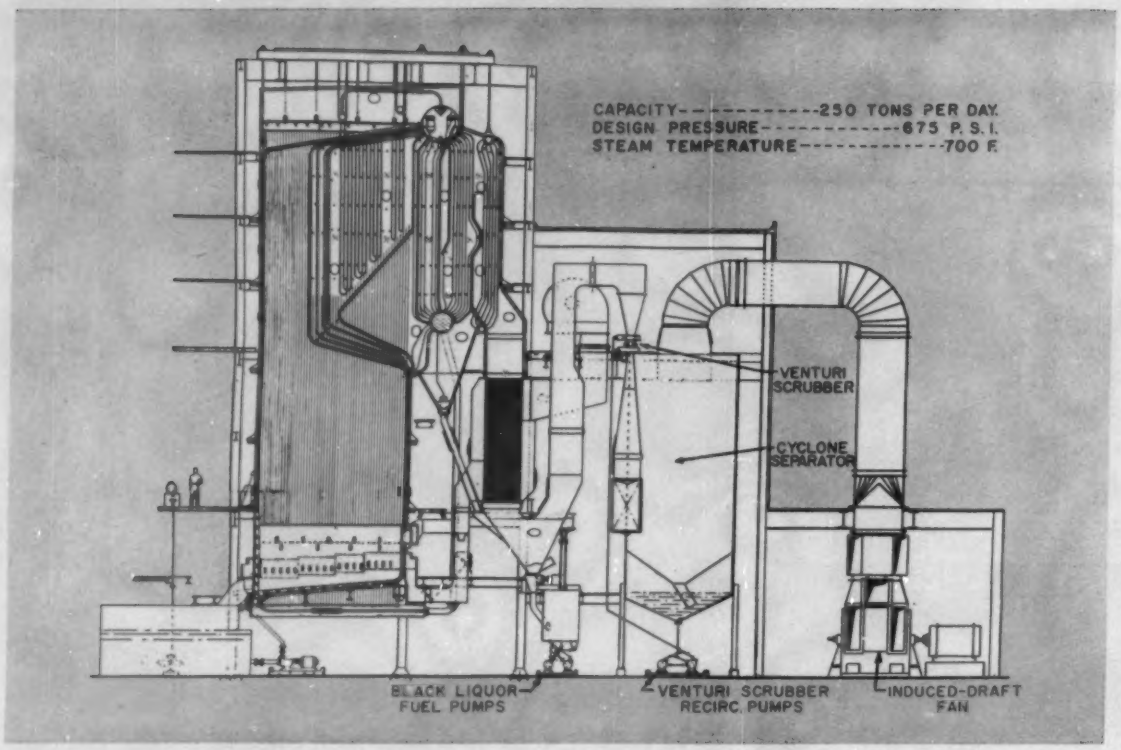


Fig. 1. Cross-section of Thilmany's black liquor recovery unit. Scrubber is by Pease, Anthony; rest of the unit is by B & W

Venturi Scrubber Saves Paper Mill's Waste Heat and Chemicals

Industrial power plants must be closely integrated with the process to be economical, but very few can claim the integration attained at the Thilmany Pulp & Paper Company. Process chemicals are used to scrub flue gas, which concentrates the chemical for re-use

Fig. 2. Top of cyclone, showing liquor piping used to keep cyclone walls wet for improved ash collection efficiencies

ENGINEERS have a tendency to get in a rut with their thinking. Take this business of scrubbing flue gas. Traditionally it has been done with water — and not without some good economic reasons. But the engineers at Thilmany Pulp and Paper Co. and a couple of equipment fabricators made a break with tradition in this field and came up with something very effective, very economical and very easy to operate. One operator and one helper run the new unit.

Thilmany's problem called for the recovery of heat through the combustion of solids in the spent black liquor (used in the pulping process), and the reclamation of as much of the chemical as possible. If heat could be recovered from the stack gases, so much the better.

Thilmany's solution to this problem called for pre-concentration of the liquor in evaporators; final drying in the furnace, where the remaining solids are burned; recovery of the molten chemical "slag" formed in the furnace; recovery of the chemical carried over in the flue gas in a scrubber using black liquor as the cleaning fluid, which re-cycles the chemical back to the furnace with the fired liquor; and, utilization of the scrubber as an evaporator to increase the concentration over that attained by the preceding evaporators, *resulting in a stack temperature of only 180 F.* In more detail, the system operates as follows:

Spent liquor with 62 per cent solids is sprayed on the side and rear walls of the boiler furnace with a unique rocker-action spray fitting, which simultaneously travels up and down and side to side. The liquor is concentrated instantaneously through evaporation, leaving a char residue on the walls. This residue is nearly 100 per cent dry fuel. Fuel thus dried and concentrated resides briefly on the

walls, then cascades to the furnace bottom where it forms a fuel bed.

An air preheater between the furnace and scrubber heats incoming air to about 300 F before this air hits the fuel bed. As the black liquor char burns, most of the chemical present melts down and runs off as a continuous slag tap into a quenching and dissolving tank. Here the chemical goes into solution as re-usable green liquor.

Products of combustion (and the evaporated liquor) rise to pass through the boiler screen, superheater, boiler, economizer, air preheater, venturi scrubber (atomizers), cyclone separator, and the induced draft fans before being discharged through a stack to the atmosphere. The combustion and recovery processes maintain the normally-objectionable liquor odors at a low level.

Gases from the air preheater still contain much sensible heat, and this heat is put to work. That part of the chemical which was not tapped off as molten slag is still present.

By using 62-per-cent-solids black liquor as the scrubbing liquid, it is possible to trap the larger part of carried-over chemical from the flue gas while simultaneously concentrating the black liquor still further. Additional collection efficiency is obtained by keeping the cyclone walls wet with 62-per-cent-solids liquor.

Liquor entering this part of the concentration system has only 42 per cent solids and is the product of evaporators elsewhere in the process. The weak product is fed into the base of the separator, the flow rate being controlled by a float valve (see illustration). Scrubbing liquor precipitating to the bottom of the separator has a much higher concentration than the 62-per-cent-solids at which it was sprayed into the flue gas, but it is diluted by the fresh supply of 42-per-cent liquor back to the average system concentration of 62 per cent.

Proportions of the recirculating liquors are adjusted so that for every six gallons pumped from the base of the cyclone, four go to the venturi scrubber, one gallon goes to wet the cyclone walls, and one gallon goes to the mixing tank en route to the boiler furnace. Hence, for each gallon actually fired, an additional five gallons is recirculating through the system.

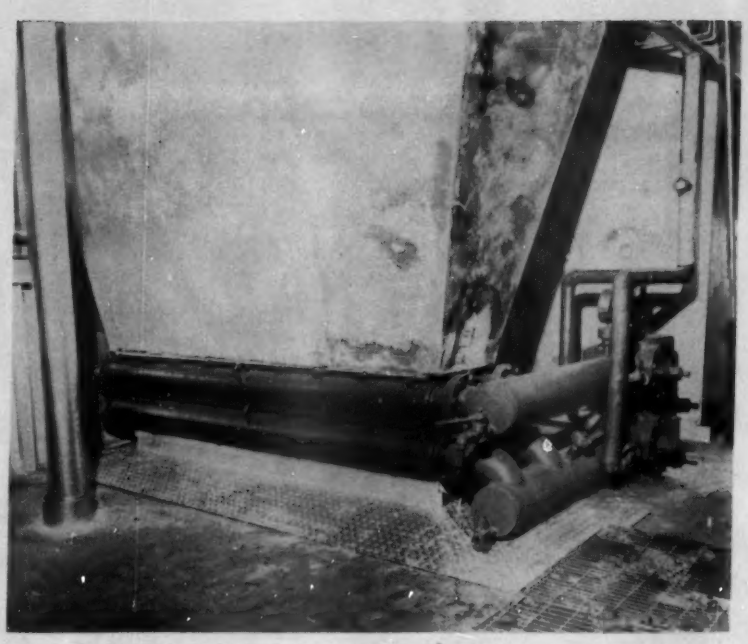


Fig. 3. Venturi throat and spray headers through which black liquor can be fed. Separate headers permit stopping one set of sprays while the other is cleaned out

Two pumps, either of which can carry the load alone, are equipped with basket-type strainers. Motor-driven scrapers remove the solids from these units, and the scrapings are fed to the mixing tank for enrichment of the fired liquor. Two headers are installed on each side of the venturi throat, but only one on each side is used at any one time. The second pair is used when (and if) cleaning of the first pair is required. Apparently the strainers are doing an excellent job.

Small orifices in the opposing pair of headers admit the liquor into the high-velocity stream of flue gas as it speeds through the throat constriction. This gas is rather heavily laden with dust, which is picked up by the atomized droplets of liquor. Heat absorbed from the dust and the hot gas flashes off a large part of the liquor as vapor. The remainder is concentrated through acquisition of solids and loss of liquid to produce a very "rich" liquor.

As the mixture of gas, vapor and rich liquor enters the cyclone, it is whirled outward along the wet wall of the cyclone for a final separation. Flue gas leaving the scrubber has a concentration of 0.4 grains dust per cu ft gas, whereas its concentration (loading) at the venturi scrubber entrance is about 3.9 grains.

Chemical collection has been running at about 90 per cent efficiency, and the heat recovery is so effective that the flue gas temperature is down to 180 F under normal conditions. This heat is enough to evaporate 12,000 lb water per hr from the black liquor, thereby saving the 3000 lb per hr of steam required to do the same job in the multiple effect evaporators. Remember, this heat is recovered *after* the flue gas has passed the economizer and air preheater.

About two years of operation have proved the unit discussed here. Its selection was based primarily on the space and capital investment it required, both of which were low, but the operating success shows the decision to be good from a number of viewpoints. The one disadvantage, relatively high power requirements for the system compared with others, is more than overcome by the combination of good heat and chemical recovery, low cost, and low space requirements.

We consider this development to be one of the finer examples of cooperation between customer engineers and suppliers — with especial emphasis on the integration of the power and production operations.

Table of average performance data shows an 89 per cent collection efficiency

	TO SCRUBBER		FROM SCRUBBER
BLACK LIQUOR FLOW, LB./HR. TO FURNACE		50,000	
LIQUOR PRESSURE AT VENTURI HEADER, PSI		30	
DRAFT LOSS ACROSS VENTURI THROAT, IN. WATER		30	
DRAFT LOSS ACROSS SEPARATOR, IN. WATER		4	
FLUE GAS TEMPERATURE, DEGREES F	485		180
BLACK LIQUOR TEMPERATURE, DEGREES F	190		180
BLACK LIQUOR SOLIDS, %	42		62
DUST LOADING, STD. DRY GAS, GRAINS/CU. FT.	5.67		0.66
DUST LOADING, STACK CONDITIONS, GRAINS/CU. FT.	3.90		0.40
COLLECTION EFFICIENCY, BASED ON STD. DRY GAS LOADINGS, %		89	
SALTCAKE LOSS, LBS/DAY		4,500	

They Stopped the Water Hammer — — — — Pipe Sizing Was Wrong!

A reader's question in our Aug. '53 issue asked for solutions to a problem of water hammer in a condenser tailpipe. It turned out to be more of a puzzler than had been expected, but now, after many attempts, it has been cured. Here's how problem was solved

By E. E. M.

IN AUGUST 1953 POWER ENGINEERING published a problem that we had encountered with our newly installed steam-jet refrigeration systems.

Our problem was to determine the cause and get rid of a persistent regular thumping sound in the vicinity of the 90 deg bare elbow. The sound was deceptively similar to a "water hammer", and that became our name for it.

This water hammer was not heard when the vacuum in the condenser was less than 27.8 in. Hg, nor was it present when the stream ejectors were turned off and condensing water allowed to run through the tailpipe without the condensate from the ejector steam.

Original Installation

The original installation was as shown in Fig. 1. The operation and performance of the system were entirely satisfactory but inasmuch as a 27.8 in. Hg vacuum in the condenser was insufficient to create the 29.75 in. Hg vacuum in the evaporators necessary to chill the cooling water to 40 F we had to decide on one of the four following courses:

One, accept the water-hammer or thumping noise. This was not desirable because the tailpipe was in a chase extending from the roof of a five-story building to a hotwell under the first floor slab. The noise was a decided distraction to the occupants. Also we were not sure what effect there would be, in time, on the pipe since every "thump" produced a reactive movement in the pipe.

Two, change the three steam-jet ejectors to obtain sufficient compression range to increase the pressure of the water vapor from 29.75 in. Hg vacuum in evaporator to 27.8 in. Hg vacuum in the condenser. Normally, the primary booster ejector compresses the vapor about 1.5 in. since this provides a convenient condensing temperature. Increasing the range from 1.5 in. to (29.75 −27.8), 1.95 in., practically 2 in., meant additional capital expenditure for new ejectors, and would add considerably to the annual operating cost in increased steam consumption and increased water flow to condense the additional steam. Since these changes were estimated to involve about $3500 to $4000 in capital and about $2500 per year additional for steam this course was also decided against.

The third alternative, and least desirable from an economic standpoint, was to rearrange the equipment so that the tailpipe would drop vertically straight down from the outlet at the bottom of the condenser to the hotwell.

The fourth, and seemingly least expensive of these three alternates, as well as a probable cure, was to remove the two 90 deg ells at the hotwell entrance and substitute two 45 deg or less angled ells to approach the straight vertical drop normally employed.

We were reasonably certain that the source of our difficulty was in the 90 deg ells. This hammer was believed to be due to entrained air or vapor being set free because of turbulence at the 90 deg base elbow; and then, being unable to escape because of the solid column of water above is imploded (opposed to exploded) by the falling water.

Other Possible Reasons

Other reasons set forth for the hammer were that: (1) The barometer condenser was too small and large amounts of uncondensed vapor were passing down the pipe and then being collapsed above the ell by falling water. (2) The lack of surface or poor condensing action was allowing water to leave the condenser at a temperature corresponding to the pressure existing in the tailpipe with resulting flashing taking place and causing hammer. (3) Insufficient deaeration of water was being effected in the condenser and the turbulence due to the right angle turns, plus any trapped vapor, was causing a condition somewhat like cavitation. The possibility of insufficient removal of non-condensables was discarded since the secondary ejectors were judged adequate.

The problem as we have stated it appeared first in the August 1953 issue of POWER ENGINEERING in the hope that someone might have been faced with a similar situation and be able to give us the benefit of his experience.

Many readers very generously replied to the question and we certainly appreciated their interest as well as the time they spent in analyzing the problem. The majority of the answers showed that considerable thought as well as no little research were given over to the knotty question "what causes water hammer in this tailpipe?"

Most answers were in agreement that water vapor or air was being trapped in the tailpipe and the condensing or collapsing of these bubbles by pressure changes, temperature changes, or colliding slugs of water was causing the hammer.

Tailpipe Flashing

Some of the answers proposed that rather than the hammer being the implosion of bubbles, it was the piston-like action of water rushing into a void left by a bubble and being suddenly stopped by a solid body of water.

Tailpipe flashing, caused by minor fluctuations in pressure, but sufficient to vaporize some of the heated tailpipe water, was put forward by several of the answering readers. The vapors formed by this flashing were thought to have collected into a bubble which acted to prevent normal flow of water through the tailpipe until such time as a sufficient head of water was built up to collapse and condense the vapor bubble. This collapse and subsequent inrush of water caused the water hammer.

Variation in outflowing water would

About the Author

E.E.M. is Utilities Engineer for one of the largest manufacturing firms in the country. For a number of reasons connected with this water hammer problem, he has asked that neither his name nor that of his company be made public. However, we can assure our readers that a very competent engineering staff gave a great deal of time and thought to this problem, and readers should find details of their investigation interesting and instructive

be corroborative evidence of tailpipe flashing, but visually we could not detect any variation. Temperatures taken of the water and gage readings of the pressure in the tailpipe at the tee indicated that tailpipe flashing was a doubtful cause of the hammer.

One of the answers suggested bleeding air into the condenser in order to decrease the vacuum slightly and thus possibly minimize any flashing tendency.

Several answers were of the opinion that our only chance of getting rid of the hammer was to straighten out the tailpipe or to pitch it sharply downward. A straight tailpipe or one with no lesser inclination from the horizontal than 45 deg is the accepted standard for barometric condensers. It was also our belief that we could completely eliminate the hammer by changing the two 90 deg ells for something less.

One of the answers that we were very anxious to try was one received from a Mr. J. L. Hess of the Oklahoma Gas & Electric Company. Mr. Hess believed that cavitation at the tee, where the water changes direction 90 deg, was causing the water hammer.

Cavitation?

He stated that very low pressures can be obtained below the wide curve with only moderate water velocities, and pressures in the neighborhood of 29 in. Hg could occur.

This pressure reduction, Mr. Hess opined, caused dissolved gases and vapor to expand forming large bubbles which were breaking off and becoming entrapped in the falling water column.

At the pressures existing in the tailpipe, these bubbles would probably retain their form until a point of much higher pressure was encountered, probably at the base elbow where the water again changes direction.

Mr. Hess suggested inserting a water connection immediately below the lower inside curve of the tee. The admission of water at this point would, it was believed, raise the pressure high enough within the pipe that cavitation could not occur.

Improvement with 22½ deg ells

Unfortunately, due to the structure immediately surrounding the tee we could not try out Mr. Hess' suggestion sufficiently well to do it justice, though we did want to.

Actually, at the date of our forwarding the problem to you we had completed the work of changing the 90 deg elbows to 22½ deg elbows and the installation then was as is shown in Fig. 2.

Several days of operation with the 22½ deg ells in place were very satisfactory. The hammer had completely disappeared. We were able to chill the cooling water to 42 deg with a vacuum of 28.4 in. Hg. The condensing water supply temperature was about 70 F and the flow rate

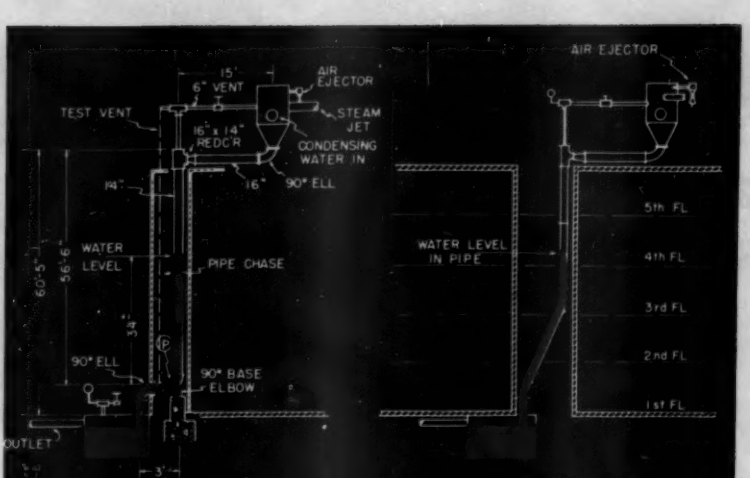


Fig. 1. Diagram of original installation of barometric condenser with two 90 deg ells in tailpipe

Fig. 2. Shows 90 deg ells in tailpipe replaced by 22½ deg ells. This did not cure the trouble

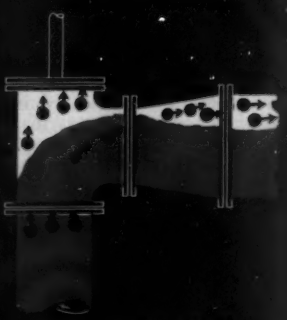


Fig. 3. With low rate of flow of condensing water air and vapor can escape between water and pipe

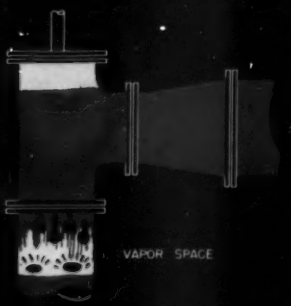


Fig. 4. With high rate of flow air and vapor are trapped between tee and top of water column

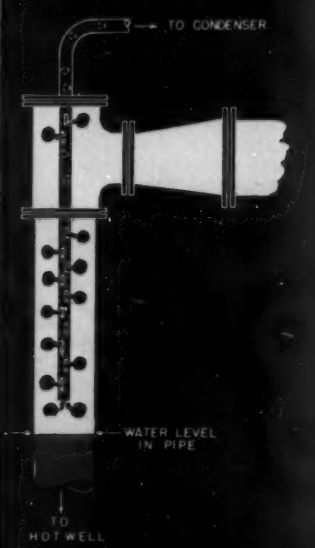


Fig. 5. Suggested method of venting vapor space between tee and top of water column in tailpipe

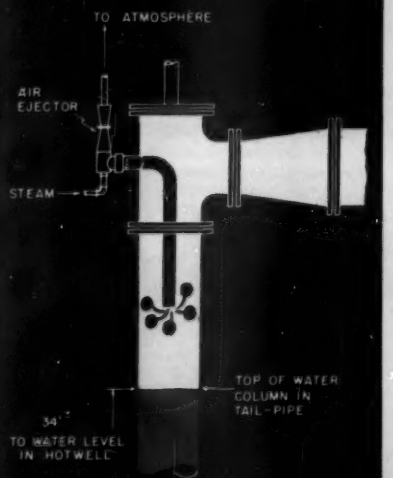


Fig. 6. Suggested installation of steam jet air ejector to vent air/vapor from top to tailpipe

less than needed with maximum temperatures. As the condensing water temperature rose above 70 F it was necessary to increase the flow in order to maintain the required vacuum. With this increase in flow the thumping noise returned.

Previously the noise had appeared to originate in or very near to the 90 deg base elbow. It gave a rather sharp cracking sound. Now the thump appeared to come from higher up in the tailpipe, somewhere near where the top of the water column would be. The sound had lost its sharpness and the cracking sensation had changed to a deeper less irritating, but still undesirable noise. Also, the water hammer was less frequent. The reactive movement of the pipe was still very much in evidence.

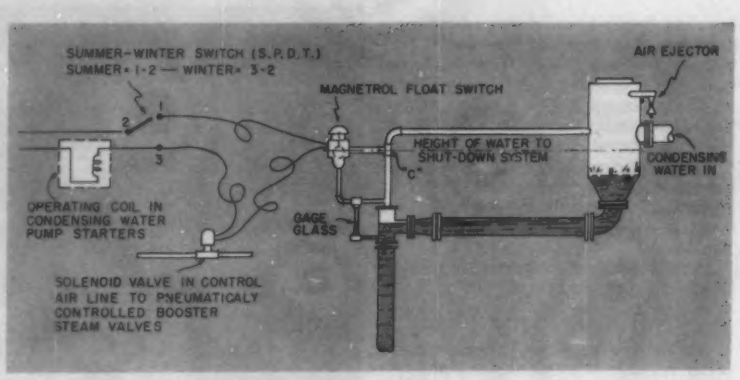

SUMMER-WINTER SWITCH (S.P.D.T.)
SUMMER- 1-2 — WINTER- 3-2
AIR EJECTOR
MAGNETROL FLOAT SWITCH
HEIGHT OF WATER TO SHUT-DOWN SYSTEM
"C"
CONDENSING WATER IN
OPERATING COIL IN CONDENSING WATER PUMP STARTERS
GAGE GLASS
SOLENOID VALVE IN CONTROL AIR LINE TO PNEUMATICALY CONTROLLED BOOSTER STEAM VALVES

Fig. 8. Final arrangement of system. If butterfly damper closes accidentally, the pump motors will stop automatically to prevent water backing up in the system

Tailpipe Vent Suspected

At this point we stopped and reviewed every suggestion and plan proposed originally. One idea that had not been fully discussed was to restrict the flow of condensing water from the hotwell so that the water level in the tailpipe would rise. The original thought behind this plan was to decrease the free fall height of water as well as raise the level in the tailpipe where the vacuum pressure changes to atmospheric.

Continued discussion and study of the problem, and the possibilities of improvement to be obtained from raising the water level, led to my second letter to your magazine in October 1953. (*This was published as an interim report on the problem on pp 94, 95 of the December 1953 issue of* POWER ENGINEERING. — *Ed.*)

We were still certain that entrapped air or vapor in the vertical leg of the pipe was causing the hammer. Previously we presumed the 90 deg ells had been the source of the hammer by causing an effect similar to cavitation and the air released at the base ell was trapped by the column of water above it. Since changing the ells from 90 deg ones to 22½ deg ells would practically remove any great degree of turbulence and yet the hammer was still present, the cause of the hammer was ascribed to something in addition to the ells.

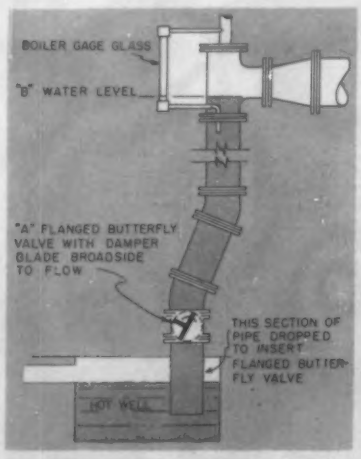

BOILER GAGE GLASS
"B" WATER LEVEL
"A" FLANGED BUTTERFLY VALVE WITH DAMPER BLADE BROADSIDE TO FLOW
THIS SECTION OF PIPE DROPPED TO INSERT FLANGED BUTTERFLY VALVE
HOT WELL

Fig. 7. Shows tailpipe after installation of gage glass and butterfly valve

In re-examining the problem we decided that the condensing and air removal equipment was performing as efficiently as could be expected. If our air ejectors were not removing air as expected, we could not possibly maintain the desired vacuum. At atmospheric pressure or a moderate vacuum, the presence of a little air does not make too much difference, but as the vacuum rises the effect of air is very serious. Since 100 per cent deaeration of the cooling water in the condenser would be practically impossible, the small amount of air contained by the cooling water was probably separating from the water at the point of first turbulence — at the tee — and was not being vented through the 6 in. vent line at the top of the tailpipe, but was being carried down or being pushed down by the onrushing water. Also, since the distance in the tailpipe between the tee and the top of the solid column of water was considerable, and since this space was under a vacuum, deaeration could and probably was taking place here.

This reasoning led us to re-examine the means we had provided for venting the tailpipe. Normally, in a straight pipe installation, the length is only sufficient to provide the 34 ft solid column of water and the entrained air drawn out of the condenser by the falling water finds its way back up the straight tailpipe and is ejected through the secondary ejector and the dry ejector to the atmosphere.

Originally, as mentioned above, our reasons for raising this water level centered about (1) preventing free falling water from acting like a piston in the pipe and (2) also raising the pressure level in the tailpipe.

It was during this discussion of how vapors or air could be trapped between the tee and the top of the water column, that the possibility of a water seal being formed at the tee was first mentioned.

This possible sealing effect, as shown in Figs. 3 and 4, could have caused entrapment of air or vapor.

There were three ways to dispose of this possible sealing effect. The first way would be to extend the 6 in. vent down into the tailpipe as shown in Fig. 5. This extended vent pipe would be slotted as indicated to provide as many openings as possible for air and/or vapor collection and withdrawal.

Butterfly Valve Solves Problem

A second method was to install an air ejector in the tailpipe below the horizontal run to draw off whatever air and/or vapor was forming or collecting there. (Fig. 6)

The third and probably the most practical method, was to raise the level of the water in the tailpipe so that the entire vertical leg up to the horizontal pipe would be a solid column of water.

This was decided as most desirable because the vapor space below the horizontal run would be gone and any possible deaeration would be confined to above the water level. Thus, with the raised level we would break the seal and also isolate the vapor-forming atmosphere to an easily vented area.

To restrict the flow of water, some adjustable type of orifice or valve was needed. Since a 14 in. valve was much too large and expensive to install, and an adjustable uncalibrated orifice not practical, a butterfly valve, similar to that used in horizontal gas lines was selected as the most suitable and least expensive way to test this latest theory.

In order to install the valve, it was decided to break the 14 in. pipe connection at point "A" in Fig. 7, and insert the valve between the flanges. The valve used was ideal for this since it had an outside control and a worm and gear arrangement to give a small damper movement, and at the same time maintain the set position. Due to the small distance, 4 in. from flange face to flange face, the installation would not be too difficult.

In order to check water level in the tailpipe, a 36 in. boiler gage glass was

installed at the tee in the pipe as shown in Fig. 7.

The installation was completed and checked during August of 1954 when condensing water temperatures were highest and cooling demands greatest.

We were extremely gratified to find that raising the water level to point "B" as shown in Fig. 7 was sufficient. We were able to maintain a vacuum as high as 29 in. Hg in the condenser with maximum water flow and no sign of the hammer or thump.

We had one serious concern in using a valve of this type. During start-up, with the damper in a partially open position, the shaft or blade might not be sufficiently strong to withstand the impact of the falling water and if it snapped or broke the damper could fall, closing the tailpipe and completely blocking the passage of water.

A stoppage such as this would force water to back up into the condenser and since the air ejector system was the only means by which this backed-up water could overflow, it was decided to provide a liquid level control in the tailpipe to shut-off both the booster steam ejectors and the condensing water pumps.

Figure 8 shows the final arrangement of the system with the controls in place. If the butterfly damper for some cause becomes closed and water backs up, the switch will break contact and de-energize the solenoid valve in the control air line as well as the holding coil in the starting circuit of the two condensing water pumps when the water level reaches point "C".

Since the condensing water pumps are used the year round to provide cooling water in other areas, a single pole double-throw switch for a summer winter change-over was provided. In this way the barometric tailpipe and the booster ejectors could be maintained in a shutdown condition during winter without affecting the operation of the condensing water pumps.

Since installing this steam-jet system with the many right angle turns in the tailpipe, we have heard of several other ones that had much longer tailpipes and more right-angle turns.

In none of these was there any noticeable thump or hammer, and we believe ours would have been just as quiet if proper precautions had been taken in sizing the pipe so that there would have been sufficient clearance in the pipe to allow air and/or vapor to pass upward against the downward flow of water.

We thank you and your many obliging readers for the sincere interest taken in our problem.

Diesel Power on Display

A GIANT OUTDOOR EXPOSITION portraying the dramatic contributions of Diesel and aircraft power to America's industrial economy will be staged by General Motors on Chicago's lakefront August 31–September 25.

It will be called the Powerama, and will dsiplay the latest in land, air, and marine equipment produced or powered by GM's Diesel, aircraft, and heavy equipment divisions.

In announcing this exposition, Harlow H. Curtice, president of General Motors, went on to say "Our aim in the Powerama is to unfold the seldom-heard but truly exciting story of how relative newcomers on the industrial power scene — Diesel and gas turbine engines — are giving the nation new muscles to build its roads, cut its timber, drill its wells, clear and plow its fields, propel its ships and aircraft, drive its trains, and turn the wheels of its machines."

Planning a giant show of Diesel and aircraft power are Harlow H. Curtice (left), president of General Motors, and C. R. Osborn, vice president in charge of GM's Engine Group, as they inspect model of "General Motors Powerama."

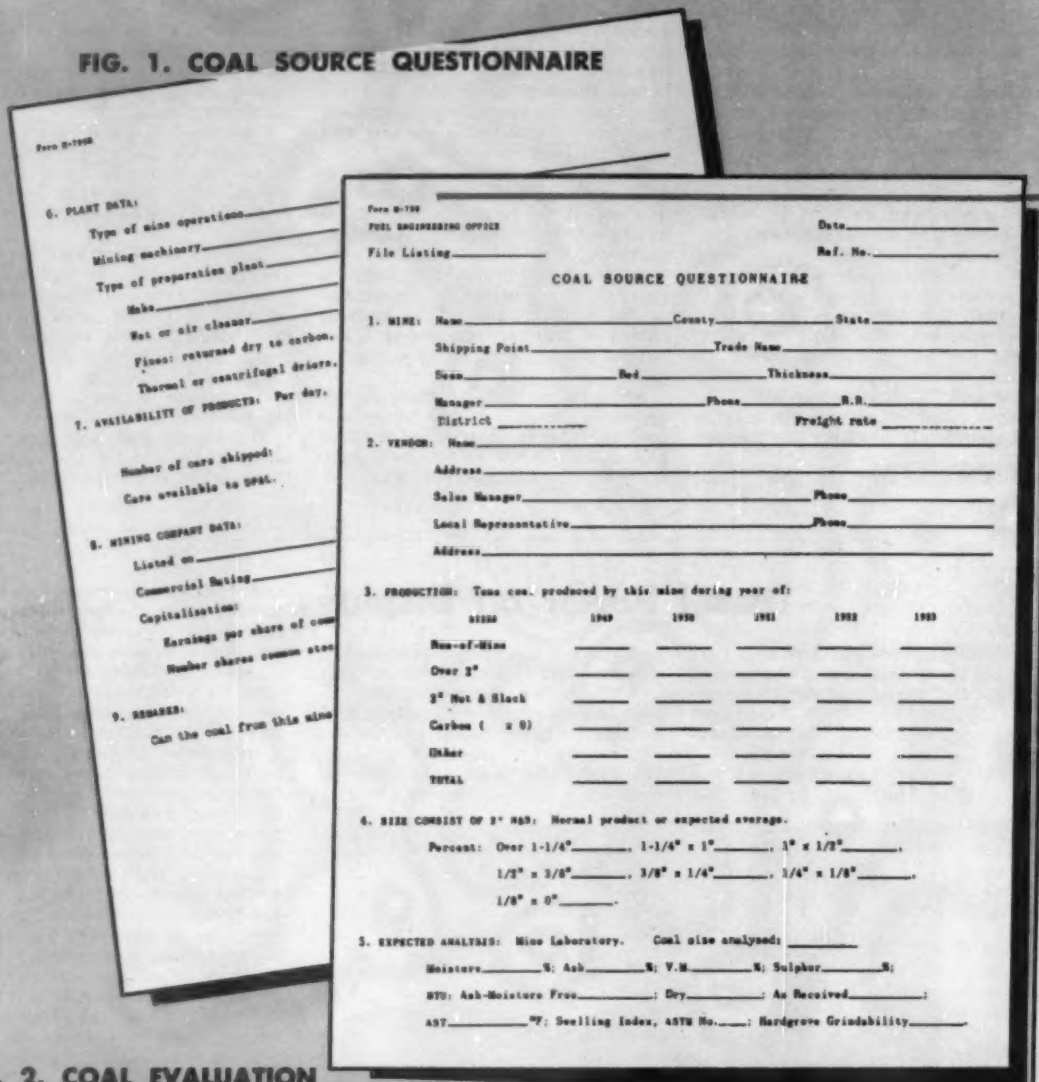
Introduced at the Powerama will be a lightweight, low-cost passenger train designed and built by GM at the request of a committee of railroad presidents, and also featured will be the XP-21 Firebird, first gas turbine automobile built and tested in the United States. But the top stars of the Powerama will be the big-muscled members of the GM family — the dump trucks, locomotives, scrapers, tractors, boats, and a variety of engines and other equipment.

In a sidewalk superintendent's dream come true, these big fellows will be available for close-up inspection and many will go through their paces in actual operation.

Other Powerama exhibits are:

The world's largest dump truck. An M-48 tank with the control apparatus *outside* where spectators can watch an operator control the steel monster. A full-scale model of a vertical rising aircraft, showing how the "Pogo" plane takes off "straight up." An F-89 "Scorpion" fighter plane. An oil drilling rig in actual operation. An operating saw mill, cutting up giant timber. An operating cotton gin. A high-speed Diesel locomotive, mounted so thati t will "run" without moving. Visitors will be able to operate it. A full-scale exhibit showing all the steps in building an actual road. A GM Diesel engine used in the world's fastest submarine. Scores of other exhibits including the latest developments in Diesel-powered transportation, plowing demonstrations, earth-moving demonstrations, and a variety of engines and cutaways.

FIG. 1. COAL SOURCE QUESTIONNAIRE



Form D-7958

6. PLANT DATA:
Type of mine operations
Mining machinery
Type of preparation plant
Make
Wet or air cleaner
Fines: returned dry to carbon.
Thermal or centrifugal driers.

7. AVAILABILITY OF PRODUCTS: Per day.
Number of cars shipped:
Cars available to DP&L.

8. MINING COMPANY DATA:
Listed on
Commercial Rating
Capitalization:
Earnings per share of com
Number shares common stoc

9. REMARKS:
Can the coal from this mine

Form D-7958
FUEL ENGINEERING OFFICE
Date
File Listing
Ref. No.

COAL SOURCE QUESTIONNAIRE

1. MINE: Name County State
Shipping Point Trade Name
Seam Bed Thickness
Manager Phone R.R.
District Freight rate

2. VENDOR: Name
Address
Sales Manager Phone
Local Representative Phone
Address

3. PRODUCTION: Tons coa. produced by this mine during year of:

SIZES	1949	1950	1951	1952	1953
Run-of-Mine					
Over 2"					
2" Nut & Block					
Carbon (x 0)					
Other					
TOTAL					

4. SIZE CONSIST OF 2" NAS: Normal product or expected average.
Percent: Over 1-1/4". 1-1/4" x 1". 1" x 1/2".
1/2" x 3/8". 3/8" x 1/4". 1/4" x 1/8".
1/8" x 0".

5. EXPECTED ANALYSIS: Mine Laboratory. Coal also analyzed:
Moisture %; Ash %; V.M. %; Sulphur %;
BTU: Ash-Moisture Free; Dry; As Received;
AST °F; Swelling Index, ASTM No.; Hardgrove Grindability.

FIG. 2. COAL EVALUATION

State W. Va.
County Boone

The Dayton Power and Light Company
COAL EVALUATION - SOURCE DATA SHEET

District 8
Sheet 1 of 4

No.	Mine	Seam	Bed	Shipping Point	Samples Where	Samples No.	Vendor	Source of Data	Size of Coal Bought	Date	Grind. Hargv.	Swelling Index	RK
1	Sabat	Dorothy	—	—	Nut	9	Hyguard Co	Nut	2x0	1947			670
2	"	"	—	—	"	3	"	"	"	1948			"
3	"	"											
4													
22													
23													
24	Wiat												
25	Purple												
26													

District 8
Sheet 1 of 4

Material Research Department
COAL EVALUATION - ANALYSES

State W. Va
County Boone

No.	Moist.	Volatile Matter	Fixed Carbon	Ash	S	Oxygen	BTU PER LB. As Rec'd.	BTU PER LB. Dry	BTU PER LB. A-M Free	FUSIONS - °F ID	FUSIONS - °F SF	FUSIONS - °F FF	RATING B/M	RATING Grade	No.
1	5.41	31.69	53.32	9.54	0.40		12612	13251	14260	2804	2891	2948			1
2	5.12	32.25	52.96	8.51	0.73		13046	—	15101	2709	2827	2882			2
3	9.64	33.62	55.49	6.63	0.68		13629	14200	15122	2630	2793	2871			3
4	4.33	31.96	—	7.52	0.71		13486	14096	15299	—	—	—			4
5	4.54	32.02	—	6.78	0.53		13395	14030	15104	2880	2960	3026			5
24	6.99	30.84	51.13	10.59	0.83		12186	13047	14771	2880	2962	3006			24
25															25
26															26

How Dayton P & L Makes Sure It Gets the Right Coal from New Sources

By FRED M. REITER *

TO THE NORMAL careful coal buyer, sizing up a new source of coal is not as easy as it may seem, especially when he's faced with an enthusiastic coal salesman who may expect an order on first call. Many boiler plants, both new and old, are very sensitive and can easily be hurt by the wrong coal. A high fusion coal can shut the newest designs of cyclone furnaces down as quickly as a low fusion coal can ruin the older type of underfeed stoker. If each power generating turbine is tied to its individual single boiler, without adjacent spares with common headers as in the older plants, mistakes spell trouble of the first order. The buyer has a great deal of responsibility, more than many coal representatives realize. The coal salesman should assume his own full responsibility in presenting any new coal to any buyer; he should know both the properties of his proposed coal and the limitations of his buyer's equipment. Glibness is no substitute for knowledge.

The coal producers' representatives must know that utilities have their own complete sampling systems and laboratories. They employ test engineers capable of evaluating the precise results obtained from any coal. Large power plant boilers have central instruments that record or indicate quantity of coal flowing to the burners, load on the pulverizers, amount of steam being produced, power being generated, and all other measurements that tell instantly and constantly just what the coal is doing.

Volume of coal being purchased by utilities is constantly growing, so that this market is likely to be the best coal sales outlet for years to come. Utilities are coal's best clients. No risk must be taken in losing sales in this growing market by errors of judgment in recommending improper coals for their purchase.

Actually, coal representatives have, in my experience, been very dependable. The old idea of "buyer beware" is not found in the coal business, as it may have been some years ago. But the utility buyer must continue to be cautious. He must protect the plant, one that has become very complex and expensive, when buying coal.

Here at Dayton we have developed a procedure that serves to check the procurement of coal at the start by imposing a first brake. When a coal representative presents a new source, we hand him a set of specifications. As can be observed from the copy shown in table, these specifications describe our operations and equipment, give coal property limits, sizes, approximate costs to be met, and other information that will enable the coal vendor to supply the proper coal for our stations. He need make no error in his selection and recommendation.

At the same time we give him a pair of questionnaires for his firm to fill out, one for us, the other their copy. Figure 1 shows part of two sides of this form. It pin points the source data in terms of the producer and the vendor, their personnel to contact, phone numbers, etc., as well as the exact location of the mine, its shipping point, railroad, county, state, seam, bed, and so on. We then ask for the properties of the coal, mine operations, production for the past years, supply capabilities, financial status, etc. We ask for no more than we gladly furnish the coal vendor with regard to ourselves. He can return the questionnaire by mail, along with further specific recommendations, quotations, quantities proposed, guarantees, and so on.

If the questionnaire data, prices, costs, etc., look favorable, we can, with the precise information available on the form, check the suitability of the coal without too much difficulty, from reference material that we possess ourselves. We have our own Source Book, developed from our own records, wherein the mines are listed by district, state, county and shipping point. Figure 2 shows part of two typical faces that lie adjacent to each other in this book. The average annual analyses are our own. If we had bought the coal before, the records would speak for themselves. If not, we must go further.

If we have other mines listed for

Table of specification to be completed by coal salesman at start of negotiations

	F. M. TAIT STATION	O. H. HUTCHINGS STATION
I. PLANT CHARACTERISTICS:		
Location	South Dayton, Ohio	O. H. Hutchings Station, Ohio
Freight charges, W. Va., Ky. coals	$3.66	$3.46
Delivering RR	NYC	NYC
Coal unloaded	bottom hopper	car dumper
Type of RR car wanted	hopper	hopper
Coal handling system	Skip hoist	Belt conveyor
Method of firing	Pulverized	Pulverized
Generator size	60 KW	65 KW
Furnace, type	Dry bottom	Dry bottom
Furnace, temperatures	High	Medium
Max. tonnage to any supplier, month	3,000	10,000
Shipments	Uniform daily	Uniform daily
II. COAL CHARACTERISTICS:		
Top size limits	1" to 2"	¼" to 2"
Bottom size limits	0	0
Percent ⅜ x 0 in coal, max.	50%	100%
AST —F minimum	2750	2200
Free Swelling Index, ASTM	3 to 8	3 to 8
Cost per million Btu:		
As received	27.5¢	26¢
Adjusted for moisture + ash + sulphur	27.5¢	26¢
III. COAL ANALYSIS:		
Moisture, max. (winter)	4%	5%
Ash, max.	8%	10%
Sulphur, max.	1%	2%
Volatile matter, min.	30%	29%
Btu, as received, min.	13,000	12,500
Btu, ash moisture free, min.	14,800	14,500
Hardgrove grindability—	no limits	no limits

Note: All above figures for estimating purposes only.

*Fuel Engineer, The Dayton Power and Light Company, Dayton, Ohio

the same seam, shipping point or county, we can determine the properties of this coal fairly closely from results obtained from the coal from these adjacent mines. If we have no records of similar sources close by, we proceed to the Keystone Blue Book, the handbook data of the serving railroad, and to the newest annual reports of the Bureau of Mines. If this mine, or any similar coal from adjacent mines, is not listed in these sources, we go back to the older more comprehensive technical bulletins of the Bureau of Mines, issued for each state. The Bureau of Mines bulletins list mines with their analyses and properties, by states, counties, shipping points and seams, similar to the method adopted in our own Source Book. If we find no data on the coal from this mine in any of these sources, we pause for a deep breath and then study the data furnished by the vendor in the questionnaire. We do not go to other users for their experiences, as a matter of ethics. Their methods of operation or equipment might not be comparable to ours. We may then, in case of a test order, bring up the matter of guarantees of heat content, moisture, ash and sulphur analyses. Guarantees are an assurance that the untried coal will not be too far from the specified basic values. Willingness to guarantee results does indicate faith in the product. It is not our policy to request guarantees, except for a new untried coal where some doubt may exist.

Costs

Assuming that the determined values are acceptable, costs per million Btu as received are computed. If these costs are favorable, we total the moisture, ash and sulphur, and compare these with our established standards. We then determine the cost per million Btu adjusted to our standard average value for the sum of the moisture, ash and sulphur. If the combined moisture + ash + sulphur percentages are abnormally high, station costs will be higher. Excessive amounts of these diluents must be mined, transported, unloaded, crushed, conveyed, pulverized, burned, pass through the boiler, gas and ash system, to the air or dump. There are formulas that have been developed for correcting all cost values to a standard.

We give credit to coals of low moisture, ash and sulphur content, for the benefits that accrue to these high grade coals. We get higher capacities and output from all our equipment, in final terms of turbine kilowatts, in addition to lower maintenance and production costs.

We also note the size breakdown tabulated in the five annual production columns. As large users of carbon size coal, we can expect this size to be available where domestic stoker coal is produced in large quantities. Carbon coal is more desirable in the warm dry summer months because of the water retaining characteristics of fine coal. Where the producer ships to lake cargoes, we can expect more carbon size coal during the lake shipping months of the summer. Where all of the mine output is crushed to nut and slack size, this coal is more attractive during freezing winter weather.

Mining Methods

Where no definite corroborative analyses are available on a new source, mining and preparation methods take on more significance. Strip, augur or punch mining may not seem as favorable as deep mining, although careless machine mining operations, partings, and low inherent coal properties may reduce the expected advantage of the deep mine. The inherent coal properties are best expressed in the ash-moisture-free Btu value, often called the H-value, or the heat content of pure combustible containing no ash or moisture. This ash-moisture-free Btu value provides important information. Low values give evidence of outcrop or weathered coal in some strip or augur operations. In some firing methods, such as cyclone furnaces, the ash-moisture-free Btu value becomes a critical item in its requirements. Our laboratory analyses and coal evaluation reports always carry this figure. MacQuown's reference books contain the approximate analyses of most coal sources of 1939, taken under the auspices of the Bituminous Coal Producers Board, for the eight eastern districts of the country. The ash-moisture-free Btu values are still used in the evaluation of new sources of coal, even if other results may have changed since that time.

The preparation plant data supplies very important information on what can be expected. If ¼ in. + or ⅜ in. + coals are washed only, the carbon sizes (¼ or ⅜ x 0) will not be too wet. Centrifugal drying may not suffice. Where air cleaning of the small sizes is indicated, or thermal heat drying of these small sizes is accomplished, moisture should not be a problem.

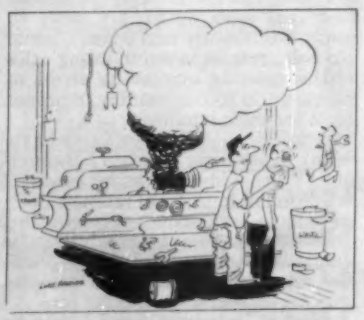
The size consist is filled out in the questionnaire. This property is important in some stoker operations, traveler, chain grate, underfeed and even in some spreader stokers. We correlate the percentage of fines, ⅜ x 0, with the ASTM free-swelling index of the coal, as requested in the analysis of the questionnaire, in an inverse ratio, for our underfeed stokers. While these figures are not so important at our pulverizer plants, the Hardgrove grindability, also requested in the analyses, could be critical with low Btu coals. We have lost capacity with the combination of low grindability and low Btu coals, especially when high moisture and ash cause the reduced heat content. Not only is the flow of ground pulverizer coal reduced, but the gross heat delivery with low Btu content coal is further diminished. The boiler instruments point this out in a hurry.

Evaluation of coal in terms of ash fusion characteristics is simple. The boilers, stokers, or other items, limit the ash softening temperature of the ash of the coal. Our specifications, see table, indicate the difference between our power stations, both of which are fired with pulverized coal in dry bottom furnaces, but with very different heat release capacities. If the buyer takes on a coal whose ash fusion characteristics are in doubt, and it turns out to be too low, and if the coal is low in Btu as well, trouble can result in a short time from an excessive accumulation of slag on the tubes. Unduly large quantities of lower fusion coal in pulverized firing in high heat release boilers can spell trouble.

Transporting Coal

Lastly, we take a good look at the problem of transporting the coal. Freight charges are very important in fuel costs. If the shipping point is located in the outer crescent freight belt, costs will be high to us at Dayton, Ohio. The addition of the 12 per cent ex parte 175 freight rate increase in Ohio greatly affected our procurement of Ohio coals. Hence the freight charges on any new coal must be examined. The location of the mine with regard to water or truck transportation is a vital item to us. The coal salesman must point out any transportation advantages on his questionnaire. This may be the decisive factor.

This article illustrates an approach to the problem of procurement of coal with particular reference to selecting new sources. It points out the value of a questionnaire, and the factors that must be listed and considered in order to avoid errors. There are undoubtedly other methods and ideas equally as good. Other buyers may have different problems and conditions to meet, requiring other standards and viewpoints. There is no doubt that with the arrival of large single unit installations of greater complexity and very high investment, new sources of coal must be carefully studied before even preliminary tests and trial runs can be undertaken.



"Don't feel bad, Les — You probably do something real well!"

Gravity Re-injection Reduces Spreader Stoker Fly Ash

SOME TIME AGO, J. I. Case Co. of Racine, Wisconsin, adopted the spreader stoker as the type of fuel-burning equipment to be used in carrying out a comprehensive improvement and rehabilitation program in all its power plants. In spreader stoker firing, the problem of fly ash collection and disposal arises. Cole H. Morrow, chief plant engineer for the company, had made many studies of this problem and had finally concluded that the fly ash could be treated not as a deficiency but as a beneficial feature because the carry-over is predominantly carbon, and therefore Morrow prefers to think of it as fly carbon.

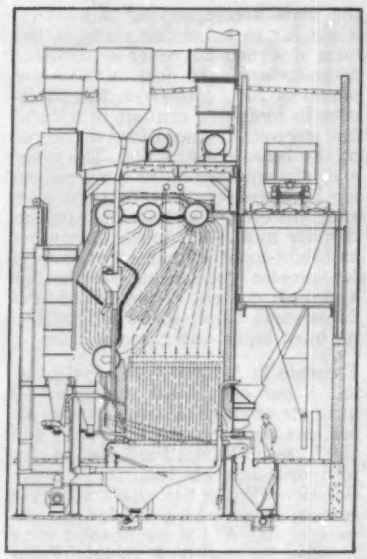


Fig. 1. Boiler of 100,000 lb-per-hr capacity, spreader stoker fired, on which fly ash re-injection tests reported here were made at J. I. Case Company

Under his direction, the Case Co. pioneered the development and application of gravity re-injection of fly ash on spreader stokers. The system and its results were discussed in detail in a paper by Morrow before the 1955 American Power Conference. The complete paper will appear in the Proceedings of the Conference, obtainable from Professor R. A. Budenholzer, Director, American Power Conference, Illinois Institute of Technology, 3300 Federal Street, Chicago, Illinois.

Morrow reports numerous tests on a 100,000-lb-per-hr boiler unit operating at 80,000 lb-per-hr (Fig. 1). In the gravity re-injection system, fly ash collected from the dust collector and economizer dust hoppers falls through ducts to a dust valve (of special patented design to produce uniform flow) thence to another hopper at the rear of the boiler, just above the level of the forward-moving traveling grate. From this hopper, the fly ash or fly carbon flows by gravity, through pipes, onto the rear end of the stoker. The fly carbon burns on the grate as it moves forward.

Results of this method of re-injection compared with other methods are shown in Figs. 2, 3, and 4.

Figure 2 shows a fly carbon balance on the boiler of Fig. 1 with all fly carbon being disposed of outside the boiler furnace. Of all the carbon fed into the furnace, 6.8 per cent passed out of the furnace in the form of fly carbon. Of this, 1.5 per cent was collected in the hopper underneath the last pass of the boiler, 2.9 per cent in the hopper under the economizer, 2.2 per cent in the dust collector, and 0.2 per cent went up the stack.

Figure 3 shows the boiler operating under exactly the same conditions but with the material from the hoppers under the last pass of the boiler and the economizer being re-injected into the furnace in the conventional manner by blowing, but still with the material from the collector being discarded outside the furnace. Carry-over leaving the furnace now amounts to 10.5 per cent of the combustible in the coal being fed to the furnace, with 1.8 per cent collected under the last pass boiler hopper, 3.0 per cent under the economizer hopper, and 5.5 per cent being trapped in the dust collector and discarded, and 1.1 per cent consumed by combustion or deposited on the grate, and still 0.2 per cent up the stack. This represents a combustible recovery efficiency of 16 per cent, and the total carbon loss from the boiler unit represents 4.8 per cent in boiler efficiency.

Figure 4 shows the results when all material was returned by gravity. Combustible recovery is now 6.6 per cent or a recovery efficiency of 97 per cent, and the total carbon loss in boiler efficiency is now less than 0.10 per cent.

All the boiler units in the Case Co. equipped with gravity fly ash return systems operate with total carbon loss of less than 0.2 per cent in boiler efficiency heat balance and at less than 20 per cent excess air at all loads from 25 per cent to full capacity. No difficulty with slagging or clinkering of any sort is experienced. Also, no fouling of the heating surfaces is experienced. As a matter of fact, none of the boiler units are equipped with soot blowers of any sort, and at no time during the past 12 years of operating experience has it been necessary to clean the gas side of any of the boiler units. The gravity return systems have functioned completely reliably, and maintenance costs have been negligible.

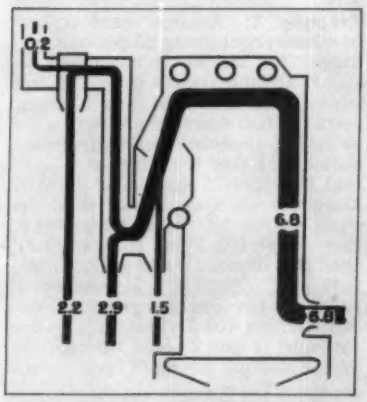


Fig. 2. Results of Test No. 1 on boiler of Fig. 1 with no re-injection of fly ash. Figures are per cent carbon to furnace

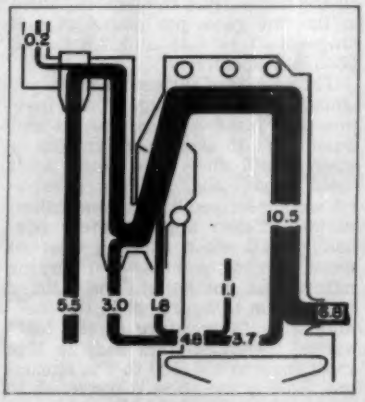


Fig. 3. Results of Test No. 2, with re-injection by air from boiler and economizer hoppers only. Figures as at left

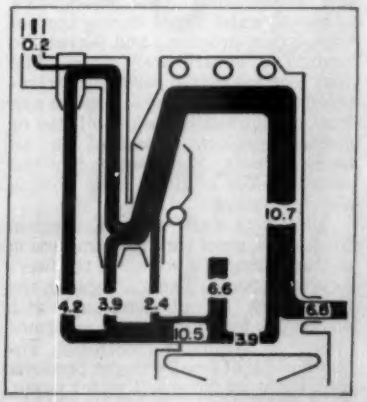


Fig. 4. Results of Test No 6 on boiler of Fig 1; total re-injection by gravity. Figures are per cent carbon to furnace

Graphical Boiler Heat Balance

By PAUL J. GROGAN*

Having accounted for losses due to moisture in the fuel (April issue, page 78), the power engineer must determine the heat loss due to hydrogen in the fuel—which burns and leaves the furnace as superheated vapor. Other boiler heat balance figuring aids will follow

4. Loss Due to Hydrogen in the Fuel

IT IS interesting to note that most natural fuels contain traces of oxygen in their ultimate chemical analysis. Such oxygen exists — apart from oxides in the mineral matter or ash — in union with hydrogen in some modified version of the original organic matter which formed the fuel. It generally happens that the hydrogen in the fuel exceeds the amount necessary to combine with the oxygen in the usual weight ratio of 1 part hydrogen to 8 parts oxygen. The union of hydrogen and oxygen in complex carbohydrates is often referred to as "combined moisture" in contrast with the "free" or "surface" moisture in a previous article.

The amount of combined moisture may be evaluated by taking $\left(O + \frac{O}{8}\right)$ where "O" is the decimal fraction of oxygen reported in the ultimate analysis of the fuel, and $\frac{O}{8}$ represents the decimal fraction of hydrogen to combine with the oxygen.

Hydrogen already in union with oxygen is not available for further combustion in the furnace. For that reason, it is often called "combined" or "unavailable" hydrogen. Nevertheless, unavailable hydrogen in complex organic compounds breaks down to simple water vapor during normal combustion processes and leaves the furnace as superheated steam. The heat loss associated with such combined moisture is identical to the loss from an equivalent weight of free or surface moisture discussed in an earlier article. Each surrenders the same number of Btu's upon cooling and condensing.

Additional water vapor appears in the furnace gases through combustion of the hydrogen in excess of the fuel's oxygen demand. The hydrogen in the fuel which is not combined with oxygen, as found in nature, is termed "free" or "available" hydrogen. The combustion of free hydrogen produces nine times its weight of water vapor. As before, the water vapor leaves the furnace in a highly superheated state. Between 1,100 and 1,200 Btu are lost per pound of vapor formed.

The similarity of water vapor loss, whether it come from surface moisture, combined moisture, or the combustion of free hydrogen, makes it possible to revise the mathematical expression derived in an earlier article to read:

$Q_H = 9H(1089 + 0.46T_{gas} - T_{air})$, where:

Q_H = loss due to hydrogen in fuel, Btu per pound of fuel

H = total hydrogen in the fuel, pounds per pound of fuel

T_{gas} = flue gas temperature, degrees F

T_{air} = combustion air temperature, degrees F

The product, "9H", is an expression of the weight of water vapor resulting from the complete combustion of a fuel containing "H" parts hydrogen per pound of fuel. For instance, a pound of coal containing 0.05 pounds total hydrogen (free hydrogen plus combined hydrogen) yields 0.45 pounds of water vapor among its products of combustion.

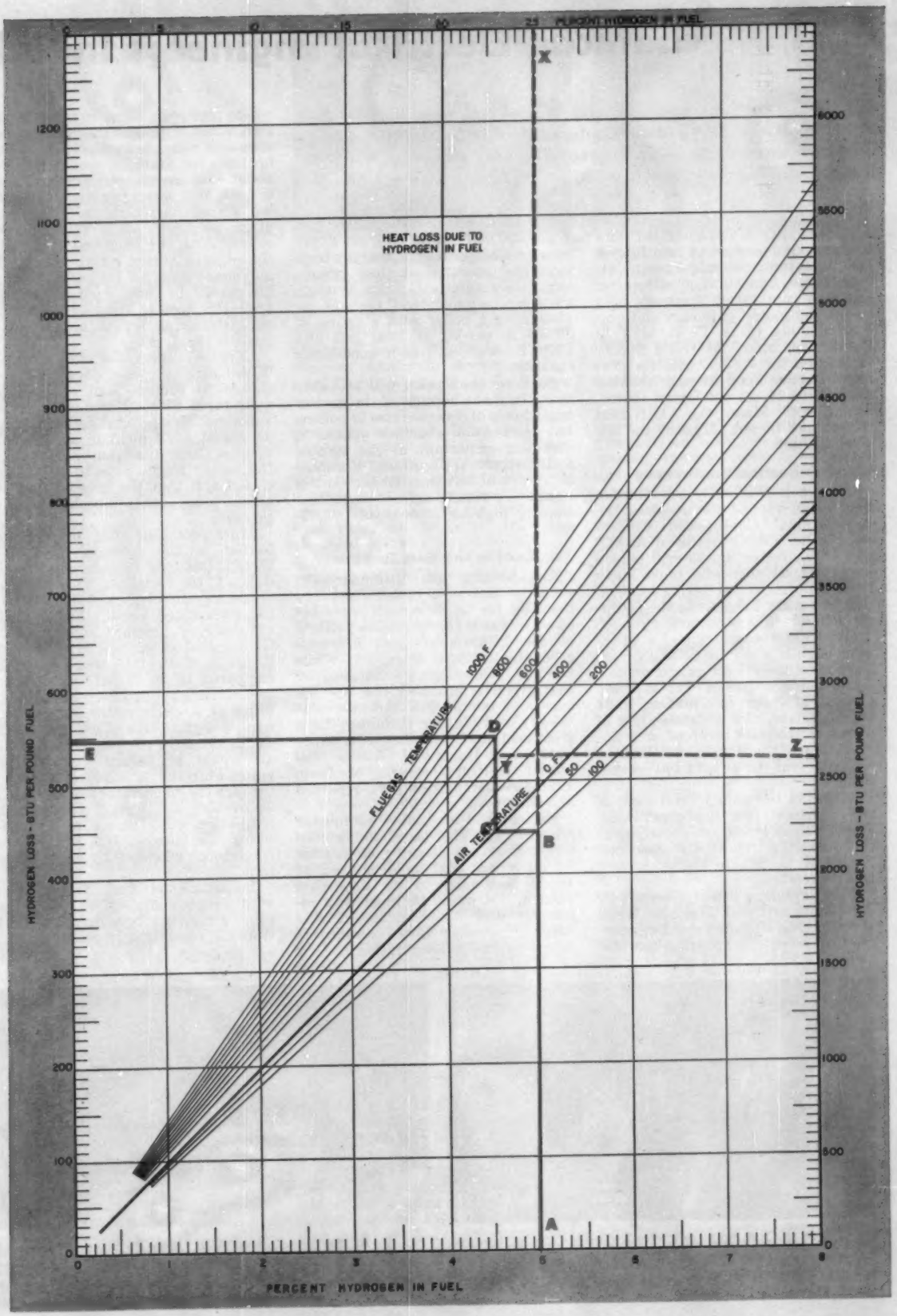
Surface moisture originally present in the fuel and moisture supplied in the combustion air add directly to the moisture contributed by the total hydrogen in the fuel. When burning coal and considering all sources of moisture, it is not uncommon to send in excess of 0.50 pounds of moisture to the stack per pound of fuel. With oil and natural gas, the total moisture in the flue gases per pound of fuel ranges 1.00 to 1.25 and 2.0 to 2.5 pounds, respectively.

The pounds of surface moisture per pound of fuel may range from a fraction of a hundredth in gaseous and liquid fuels to several hundredths in some liquid fuels and most solid fuels. Meanwhile, the water vapor released or formed during combustion varies between approximately one-half pound when burning coal to more than two pounds when burning natural gas (methane). The ratio of losses "due to hydrogen in the fuel" and "due to moisture in the fuel" varies, therefore, from 5–10 to 1 in most coals to 400–500 to 1 in natural gas. Such a variation is too much to accommodate graphically along a given linear scale and give good accuracy over the entire range. While the construction and application of the plate accompanying this article is similar to an earlier plate, it has been designed to cover a different magnitude of the loss in Btu per pound of fuel. Moreover, the difference in hydrogen content in natural fuel suggests the need for two ranges on this latest construction. The lower and left-hand ordinates are arranged for hydrogen content between zero and 6 per cent. The range has application for most solid fuels. The upper and right-hand ordinates are arranged for greater convenience when the hydrogen content is between 6 and 25 per cent. Those scales have utility for most liquid and gaseous fuels.

Example 1: Assume that a coal bearing 5 per cent total hydrogen by ultimate analysis is burned where air and gas temperatures are 100 F and 500 F, respectively. Find the loss due to hydrogen in the fuel.
Solution: Enter the chart at 5 per cent hydrogen along the lower ordinate (Point A). Move upward until intersecting the 100 F air line (Point B). Move left to the "zero degrees air and gas line" (Point C), and up again to the 500 F gas temperature line (Point D). The answer (548 Btu per pound of fuel) may be read at Point E along the left-hand ordinate.

Example 2: Assume natural gas (methane) containing 25 per cent hydrogen by weight is consumed in 100 F air and results in 400 F flue gases. Determine the Btu loss per pound of fuel due to the water vapor formed in combustion of hydrogen.
Solution: Enter the chart at 25 per cent hydrogen in the fuel at Point X along the top scale. Move down the chart to the 100 F air temperature line (Point B). Move to the left to the "zero degree air and gas temperature line" (Point C). Return vertically to the gas temperature line representing 400 F (Point Y). At the far right (Point Z) read the solution (2,670 Btu per pound of fuel).

* Chairman, Department of Engineering, and Director of Engineering Institutes, University Extension Division, University of Wisconsin. All republication rights reserved by author.


HEAT LOSS DUE TO
HYDROGEN IN FUEL
HYDROGEN LOSS - BTU PER POUND FUEL
PERCENT HYDROGEN IN FUEL
1000 F
800
600
400
200
FLUE GAS TEMPERATURE
AIR TEMPERATURE
0
50
100
X
Y
Z
A
B
C
D
E

Fuel, Mechanical, Electrical Engineers Invade

Boston, city of bean and cod, and its environs, were hosts in June to International Combustion Conference, ASME Diamond Jubilee Semi-annual Meeting, AIEE Summer General Meeting. A POWER ENGINEERING editor covered each, reports here on the high-lights

ENGINEERS from all over the United States and a number from foreign countries flocked into Boston and its environs in mid-June to attend three important Conferences. Fuel and combustion engineers held an International Conference on Combustion June 15 to 17 at MIT in Cambridge, Mass. At Hotel Statler in Boston, the ASME held its Diamond Jubilee Semi-Annual Meeting June 19 to 24. At the Ocean House, Swampscott, Mass., the AIEE held its Summer General Meeting the last week in June.

Combustion Conference

Though it frequently resembled a seminar on applied mathematics, the International Combustion Conference, under joint auspices of ASME and IME, turned up several papers important to men who must know what happens to fuel during combustion and what happens to the equipment in which it is burned.

Over 300 researchers and applications engineers of Europe and America pooled their information on this broad subject. Result was a heady mixture of design information, basic physical data, new understanding of chemical processes involved, new appreciation of the fact that combustion is one of our oldest arts but newest science.

While all the papers (and most of the discussion) proved of great value, a few of them stood out, according to the following report by Associate Editor R. J. Mitchell who covered this conference.

For example, a paper presented by John Longwell and Malcolm Weiss (both of Esso Research and Engineering Co.) revealed a spherical combustion reactor with a heat release rate of *300,000,000 Btu per cu ft per hr per* $(atm)^{1.8}$. This device has actually been built and operated at their laboratory. The magnitude of this development can be understood, perhaps, by visualizing a boiler with a rating of 20,000 lb per hr at 1000 psia and 1000 F, with a *1-cu-ft combustion chamber*.

Such an application will probably never be made because of the greater importance of *transfer* rates in boilers, but combustion chamber volume is definitely important in gas turbine and aircraft applications. Combustion rates of less than 10 per cent of Longwell's results are considered extremely high by present-day standards.

Coal in the Gas Turbine

Coal-burning gas turbines have come to assume a rather restricted meaning for us in recent years because of the highly-publicized efforts of the Bituminous Coal Research group (June issue, Page 67). While the line of development followed by that group is probably the best for coal-fired mobile gas turbines, stationary coal-burning turbines offer a great deal more flexibility. In a paper by Herbert Hazard of Battelle Memorial Institute, several of these alternate possibilities were reported and evaluated.

Besides the air-cooled combustor for pulverized coal (as in the locomotive turbine), a slagging combustor for pulverized coal could be used. It would be similar to the air-cooled version, but would be lined with refractory and would include a slag removal system. Both combustors would require ash separators.

Gas producers seem destined to an association with gas turbines where adequate water is available. A 5000-hp unit, for example, would require about 4300 lb coal per hour and 400 to 1300 lb of water per hour, depending on coal characteristics. Two types of gas producers are now being considered, one the fixed-bed type and the other a vortex retort fired with pulverized coal. Air for production of hot gas will be about 5 per cent of the cycle air. Both of these systems will require ash collectors before the combustion chambers.

Cyclone burners offer some promise in gas turbine cycles since their response to sudden load changes is quite rapid. Slag will undoubtedly be vaporized in the cyclone and condensed at some point in an efficient turbine. Other disadvantages are that the burner might have to be water-cooled and that the pressure loss is about 1 psi per atmosphere static pressure.

More promising than the cyclone burner is the spreader stoker — though this may be somewhat more difficult to visualize. This system necessarily involves a stoker within the pressurized circuit. Firing at 5 atmospheres pressure should allow feeding coal at the rate of about 200 lb per sq ft of grate area per hr, as compared to 50 lb for atmospheric pressure firing. For a 5000-hp turbine, firing at a conservative rate would require a grate area of only about 45 sq ft. About 10 per cent of the cycle air would be passed through the grates while the remainder was passed through the regenerator and admitted as overfire air. Firing without ash reinjection would minimize dust entering the turbine, but will reduce combustion efficiency by about 4 per cent.

Instantaneous load drops, even with complete shut-off of fuel, could cause a runaway because of the heat stored in combustor, regenerator and ash collector, according to Hazard.

Fig. 1. (L to r): O. A. Saunders, City & Guilds College, London; Sir Alfred Egerton, Imperial College of Science and Technology, London; Dean H. C. Hottel, MIT; Bernard Lewis, Combustion and Explosives Research, Inc.; Wm. T. Reid

Fig. 2. At the banquet of AIEE, June 29, seated at head table (l to r): Dr. C. G. Suits, General Electric Co., banquet speaker; Mrs. M. A. Princi; M. A. Princi, chairman of the AIEE Summer General Meeting, and Mrs. A. C. Monteith

New England

An overspeed trip to operate an air bleeder at the compressor outlet could provide the protection required.

Industrial Furnaces

Engineers who must keep firm control over process temperatures in metallurgical, glass, ceramics or chemical furnaces have more troubles than most power engineers realize. Need for precise knowledge in this field was presented very well by Dr. Chesters (United Steel Companies, Ltd., Rotherham, England) in a paper prepared by himself, S. W. Pearson (same company), and Dr. M. W. Thring (Professor of Fuel Technology, Sheffield University).

Dr. Chesters dealt with combustion and heat transfer in the open-hearth furnace, and the use of "calculation models" to aid in predicting performance and spot temperatures. Such a model can be used to predict *quantitatively* the effects of variables the operators might use to increase output and/or save fuel. Until now, we have been highly emperical in combustion work, but tightening space and heat release requirements make this impractical. Results obtained by Chesters, Thring and Pearson agreed within 7 per cent (calculated versus observed heat transfer).

Ralph Sherman and William Reid (both of Battelle Memorial Institute), in their appraisal of the state of combustion research, concluded that the greatest progress has been made through engineering research (as compared with fundamental research). The very fact that fundamental combustion research has been conducted is no assurance that the results will be used by designers. These still go only part of the way to their target designs through application of theory, then finish the job through experimentation. Better understanding between fundamentalists and experimenters would save huge sums in development costs.

Sherman and Reid finally called for development of a class of technical middlemen, or interpreters, who could pull the abstruse fundamental research down to an applicable level.

With the Electrical Engineers

Ocean bathing at Swampscott, Mass. was good the last week in June but only few of the more than 2100 electrical engineers attending the Summer General Meeting of the AIEE there seemed to have time to enjoy the beach — there were too many other things to do.

To begin with, there was the election of the new officers, and at the opening meeting A. C. Montieth — Monty, as he has come to be known — turned the presidency over to Morris D. Hooven, who will formally take office August 1. Mr. Hooven is electrical engineer for the Public Service Electric & Gas Co. of New Jersey. President Montieth reported that the present Institute membership of 49,000 can be expected to increase to 100,000 in ten years. In that time, he predicted that the electrical industry would double.

Fig. 3. Greetings of engineering and scientific organizations throughout the world were presented to 75th anniversary convocation of ASME; (l to r) Hon. Arthur C. Hartley, Inst. of Civil Engineers, Great Britain; Dr. Warren Weaver, AAAS; Sir Vincent de Ferranti, Chmn., World Power Conference

Fig. 4. D. W. R. Morgan, left, president of ASME, talks with Reginald J. S. Piggott, Fellow and past president ASME, at 75th anniversary convocation of ASME, of which Mr. Piggott was chairman and where Dr. Morgan introduced speakers on The Relationships of the Engineer and His Fellow Scientists

Another feature of the opening meeting was the presentation of the 1954 Lamme Gold Medal to Aldo M. deBellis of Consolidated Edison. Vice-president James Fairman of Con Ed said that deBellis was the engineer who put Con Edison in the business of 69-kv bulk underground transmission. Moreover, deBellis was also largely responsible for Con Edison's current use of metal enclosures for its high-voltage bus and switch structures.

As reported by Editor Andrew W. Kramer, the technical program was, as usual, varied and covered a tremendous range of development and techniques in the electrical art. At the dinner meeting on Wednesday night, in a speech entitled The Science of Commonplace Things, Dr. C. G. Suits, Director of Research for General Electric described, the development of the transistor and other work in the semiconductor field, Silicones, the theory of fractures in metals, direct amplification of light, and the production of diamonds in the G-E Research Laboratory. This last achievement is one to capture the imagination. Many of us were taught in sciences courses that the diamond could be made from carbon under high heat and tremendous pressure, and many reference sources credit Moissan with accomplishing this feat in 1894, but in the light of present knowledge it is certain that Moissan could not have made diamonds with the limited pressures he had at his command. Only recently, studies of the thermodynamics of diamonds provided the research team with the springboard they needed to undertake the diamond making project some four years ago. Curiously enough, the problem centered not so much upon the attainment of pressures around 1,500,000 psi but upon making pressure vessels to withstand such pressures. The first diamonds made by G-E were about $\frac{1}{16}$ of an inch long, but the prospects for making larger ones are favorable, now that the theory and techniques are understood. Current prices for industrial diamonds run up to a million dollars a pound, so continued research in this direction is sure to pay off.

Superconducting Elements

Another development of fascinating import disclosed at this meeting was that involving the use of superconducting elements in electrical computers. This development, described in a talk by D. A. Buck of MIT, is based on the phenomenon, discovered many years ago by Onnes at the University of Leyden in Holland, that many metallic conductors lose all electrical resistance when they are cooled to within a few degrees of absolute zero. This superconducting state may be removed, not only by raising the temperature again, but also by applying a magnetic field. At MIT this principle has been applied in the construction of computor elements. By winding a magnetizing coil around a very thin piece of wire, about an inch long, and immersing the structure so formed in liquid helium, the thin straight piece of wire becomes superconducting. Its resistance is *zero*. However, if a current is sent through the coil, (and this coil is made of a different metal having a lower critical superconducting temperature) the straight piece of wire instantly reverts to its state of normal resistance. In other words, by means of the magnetic winding it is possible to control the superconductivity of the straight element. Now, by connecting the magnetic winding of one such element to the straight portion of another element, and vice versa, it is possible to produce an electrical "flip-flop" similar to those formed by electron tube or

Fig. 5. At AIEE meeting (l to r) A. C. Monteith, retiring president, looks on while incoming President Morris D. Hooven is given congratulatory handshake by Secretary N. S. Hibschman

transistor circuits. By the use of many such elements, computers may be designed.

The peculiar merit of this development lies in its extreme compactness. A unit containing some ten thousand such elements, occupying a volume of say a cubic foot, can be kept cool by the use of one liter of liquid helium, costing about $3. This is indeed cheap when such a system is compared with MIT's fast computer, Whirlwind, which requires two 50-ton air-conditioning units on the roof of the building for cooling.

Of more immediate practical value is a new high-speed circuit breaker designed to operate on circuits up to 15.5 kv, and reported to have an interrupting time of one cycle and a reclosing time of 20 cycles. This new breaker was described in a paper by E. J. Field and D. L. Leatherberry of the I-T-E Circuit Breaker Co. The breaker will interrupt at one cycle and reclose twice before locking out.

Other new developments described at the meeting included a new instrument for measuring atmospheric electric potential, a new amplifier using an audio-frequency transistor power supply, a liquid scintillation detector for medical and biological use and a new type of electronic facsimile system, called Ticketfax, to flash Pullman and reserved coach seat tickets from one railroad station to another and to provide them almost instantaneously to customers at the counter.

Engineering and Science

The Engineer and the World of Science was the keynote for the discussions of some 1400 members of ASME at their Diamond Jubilee Semi-Annual Meeting June 19, in addition to 80 papers presented before the various technical sessions. Under a new plan for having officers nominated at the semi-annual meeting, Joseph W. Barker, chairman and president, The Research Corporation, was nominated for ASME President in 1956.

Boston Section's 75th Anniversary Medal was conferred on Alfred J. Ferretti and the 1955 George Westinghouse Gold Medal on Rear Admiral H. G. Rickover, USN. Honorary memberships were conferred on several foreign engineers.

This meeting also had a strong international cast. Greetings from other American societies and from those abroad were presented at a 75th Anniversary Convocation on June 21, after which leaders in the physical, biological, atomic, and medical sciences discussed The Relationships of the Engineer and his Fellow Scientists. Banquet speaker on Machines for Man was Dr. Detlev W. Bronk.

Trips to GE at Lynn, Arthur D. Little, Inc., Wyman-Gordon Co. for the men, a program of social hours, dances, tours for the ladies of the Woman's Auxiliary, a splendid night at the famous Boston Pops for all, (arranged by E. H. Barry), a clambake at historic Plymouth Harbor — all were enjoyed in the time between technical sessions.

Cheapest and best insurance for continuous and reliable electric service is a staff of power plant operators who know the equipment and how it should be operated, asserted Harold Grasse, project engineer, Black and Veatch. He outlined a training program conducted by Iowa Power & Light Co. in connection with a new $9,000,000 generating unit. It was credited with minimizing the effects of two emergencies during startup. These were handled skillfully by two operators, and the unit, now in service for more than a year, has never been off the line because of an operating error.

Accelerated Turbine Loading

Outstanding and important power plant development described at this meeting, according to Executive Editor Chester R. Earle, who covered it, was a report on Accelerated Loading of Large High-Pressure, High-Temperature Turbine Generators by W. C. Beattie, J. M. Driscoll and M. Salvage of Consolidated Edison Co. of New York, Inc.

Consolidated Edison has developed quick-starting procedures for boilers and turbines following overnight and week-end shutdowns. But during loading periods on h-p, h-t turbines, even at rates of only ½-mw per min, large temperature gradients across the massive turbine flanges cause excessive stresses in flanges and bolts and cylinder walls, and may cause axial stressing and even rubs. With the arrival of 200- or 300-mw units, loading time is important, for at one mw per min, many hours are required to bring such a unit to full and most efficient load.

The authors report tests on turbines with high rates of loading while independently heating horizontal flanges and bolts by admitting live steam to the annular space around the flange bolts, and showed how loading rate can be increased sixfold with simultaneous reduction in flange and bolt stresses.

Distribution ratios of concentrations of silica in steam to those in boiler water were determined and reported by E. E. Coulter, E. A. Pirsh and E. J. Wagner, Jr. of B&W over a range of pressures from 300 to 3140 psi, of silica concentrations in the water from 12 to 1000 ppm and of pH values of the water from 7.8 to 12.1. Mechanical carryover, determined with a radioactive tracer, was not enough to need corrections to the vaporous silica carryover data at pressures above 500 psi.

Coal and Ash Handling

Still another session that aroused interesting discussion dealt with coal and ash handling problems. Detailed description of the methods used at Martins Creek Station was given by W. H. Kopenhaver, superintendent of the station for Pennsylvania Power & Light Co.

Following this, Donald M. Given presented a paper by himself and Carl A. Marshall, both of Fairmont Coal Bureau, on coal and ash problems in small plants. Plants using from 200 to 30,000 tons of coal a year, steam loads up to 150,000 lb per hr, can be mechanized for one-man operation, with another man available for unloading coal cars, he said.

He described typical coal and ash handling systems, silos, bunkers, discussed freezing and arching problems, coal segregation, fires, scales, and operating problems. There was lively discussion of this paper.

Considerable attention was devoted to nuclear engineering. Engineering Problems of Power Reactors were detailed by Harry J. Bolwell of Combustion Engineering, Inc.

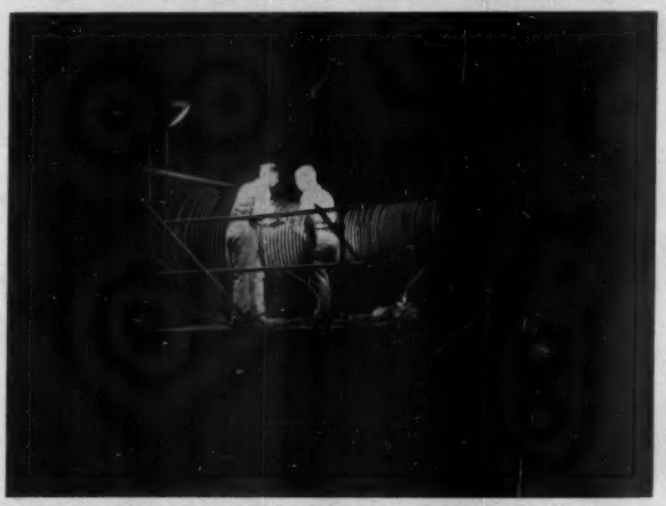
Development of a package power reactor by a group at Oak Ridge was described by A. L. Boch. In this reactor, the power cycle is of two main systems: the primary coolant and the secondary steam system. The reactor will produce 1000 kw of electric power and 3555 kw of heating steam. All parts will be designed for transport by air. Total plant cost would be $1,703,000. Operating costs would be 25.48 mills per kwh for electricity and 5.90 mills per kwh for steam. Total capital plus operating cost: 53.30 mills per kwh electricity and 12.34 mills per kwh for steam. The contract for building a plant of this type has been awarded to American Locomotive Company.

Robert Deane of Nuclear Development Associates, Inc. discussed Fast Reactor Accident Dynamics. Details of Power Removal from Boiling Water Reactors were given by P. C. Zmola and R. V. Bailey of Oak Ridge.

Quantity of electric power that may be developed within our lifetime, said Dr. B. G. Ketchum of the Woods Hole Oceanographic Institute, would produce enough radioactive waste products within a year to make a detectable change in the ocean, even though they were distributed uniformly from shore to shore.

So—You're Going to Overhaul Your Turbine Generator!

This is the fifth article in a series describing the scheduled overhaul of a 25,000 kw turbine generator at U. S. Steel Corp.'s South Works in Chicago. A list of past and future articles is given below. When all the articles have been published we plan to reprint the whole series. To reserve a copy of the reprint write to the Editor



V. REBLADING

Ten years ago it was decided to install improved blading in this unit. Part of the work was done in previous overhauls. This time the last fifty rows were replaced. Here's how operation was done

Two ten hour shifts were worked throughout the overhaul. Here men are seen starting to remove spindle blading

I. Preview of whole series. II. Planning . . . Preparation . . . Preliminary work. III. Removing turbine cover and spindle. IV. Turning turbine cover. V. Reblading. VI. Metallizing eroded shaft. VII. Work on generator. VIII. Machining turbine spindle. IX. Checking clearances. X. Re-aligning turbine spindle. XI. Balancing. XII. Miscellaneous work. XIII. Safety and time-saving ideas

REMOVING OLD BLADING . . .

Fig. 1. Removing old blading from casing. Scale around blade roots made removal difficult and air hammer was necessary

Fig. 2. Removing caulking pieces from spindle blading. As with casing, scale at blade roots made removal difficult

APPROXIMATELY TEN YEARS ago it was decided to install an improved type of blading in this turbine. In 1947 the last seven rows (61–68) were installed, and in 1951 eleven more rows (51–60) were replaced. This left 50 rows of blading to be installed, and this was done during the overhaul described in this series.

First job was to remove the old blades. After many years' service, a certain amount of scale and corrosion around the blade roots makes removal a difficult job, and the blade assemblies had to be driven out with an air hammer. Figure 1 shows a blade assembly almost out. Fig. 2 shows blading being removed from the spindle.

INSTALLING NEW BLADING . . .

Fig. 3. Blading came covered with protective coating. Before use it was dipped in solvent and dried with air jet

Fig. 4. Specially shaped tool used for tapping blade assemblies into position

Fig. 5. Installing new blading. H-p blades came in assemblies of five to eight blades, depending on their size, and each assembly slid into position as shown

Blading assemblies came from the plant covered with a protective coating. Before being installed in the turbine, the assemblies were dipped in solvent to remove the coating and were then dried with a compressed air jet, as shown in Fig. 3.

Each assembly consisted of from five to eight blades, depending on their size, and the method of installing them in casing and spindle is shown in Figs. 4 and 5. The steel pins in Fig. 6 were used to hold the spindle blades in place temporarily until the caulk-

Fig. 6. Installing new spindle blading. Pins held blading in position while caulking pieces were fitted. When caulking was completed, pins were removed

ing pieces, which lock the blade assemblies in position permanently, are all in place.

For making final adjustments to the ends of blade assemblies before installation, a surface grinder was set up on the job, as shown in Fig. 7.

However carefully boiler feedwater is treated, some impurities are unavoidable, and these, carried over into the turbine, formed, in this case, a hard scale on the blades, consisting mainly of calcium carbonate, and for this overhaul it was removed by blasting with a mixture of 140 mesh silica sand and water, as shown in Fig. 8. Other abrasives, such as fly ash or aluminum oxide, are often used for this type of cleaning operation. Silica sand was selected in this case because it cleans efficiently and makes less mess round the job than some of the other abrasives.

A sheet metal housing built around the spindle collected the mixture of abrasive and water, and from a sump at the bottom of the housing the mixture was pumped back through the hose to form a closed circuit.

As steam passes through the turbine blades, it produces an axial force on the spindle in the direction of steam flow. To balance this axial

When all these turbine overhaul articles have been published we plan to reprint the whole series. These reprints can be used before an overhaul to show new men the kind of work that has to be done, and they can be used effectively to back up a shutdown schedule by showing management why many of the operations have to take as long as they do. If you want to reserve copies of the reprint write to the Editor

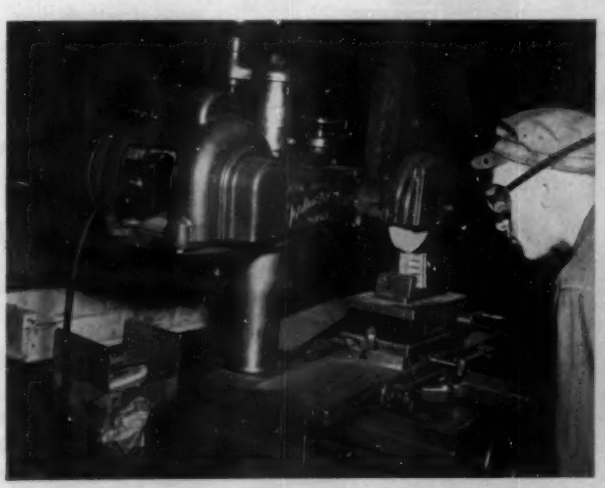


Fig. 7. Surface grinder was installed on job to make minor adjustments to ends of individual blade assemblies during installation

Fig. 8. Shows method used for cleaning hard scale off the 1-p blading with jet of fine abrasive and water

Fig. 9. Shows dummy seals which were replaced during overhaul. Note burlap and rubber hose used to keep dirt out of turbine ducts and openings during assembly

thrust and prevent excessive load on the thrust bearing, the spindle has a balance or dummy piston at the h-p end on which the h-p steam exerts a force almost equal and opposite to the total axial thrust on the blades.

To prevent steam leaking past the balance piston, the periphery of the piston has a number of ridges which fit against dummy seals in the turbine casing to form labyrinth seals, as shown in Fig. 9. In Fig. 11, the edges of the seals are being sharpened.

Other Overhaul Jobs

While reblading and other major operations were in progress, many other smaller but important overhaul jobs were being attended to. These will be grouped together and described in a separate article at the end of this series. These jobs included the overhaul and adjustment of such items as the main thrust bearing, h-p steam inlet valves, cylinder drain valves, condenser, condensing water pumps and drive motors, governor gear, flexible coupling, overspeed protection gear, slip rings, generator equalizer rings, exciter, etc.

Fig. 10. Left. Installing dummy seals. The seals were installed individually and fitted to make continuous rings

Fig. 11. Below. After seals were installed they were ground with small portable tool to give sharp edges

3-D Drawings Save Time, Mistakes and Construction Costs

Even before equipment is built, you can get a picture of it and see how all parts go together, with a 3-dimensional scalable drawing

DEVELOPMENT of the Aerial-Vu method of making 3-dimensional engineering drawings to scale has recently been attracting attention of power engineers. Accompanying drawing shows why. It is a portion of a drawing made by this method direct from the plans and elevations of the boiler manufacturer.

This drawing costs very little to make compared with cost of a scale model. A great many more man-hours were saved during construction and much more valuable information was available with drawings costing less than $3000 than a model costing $20,000 could have produced.

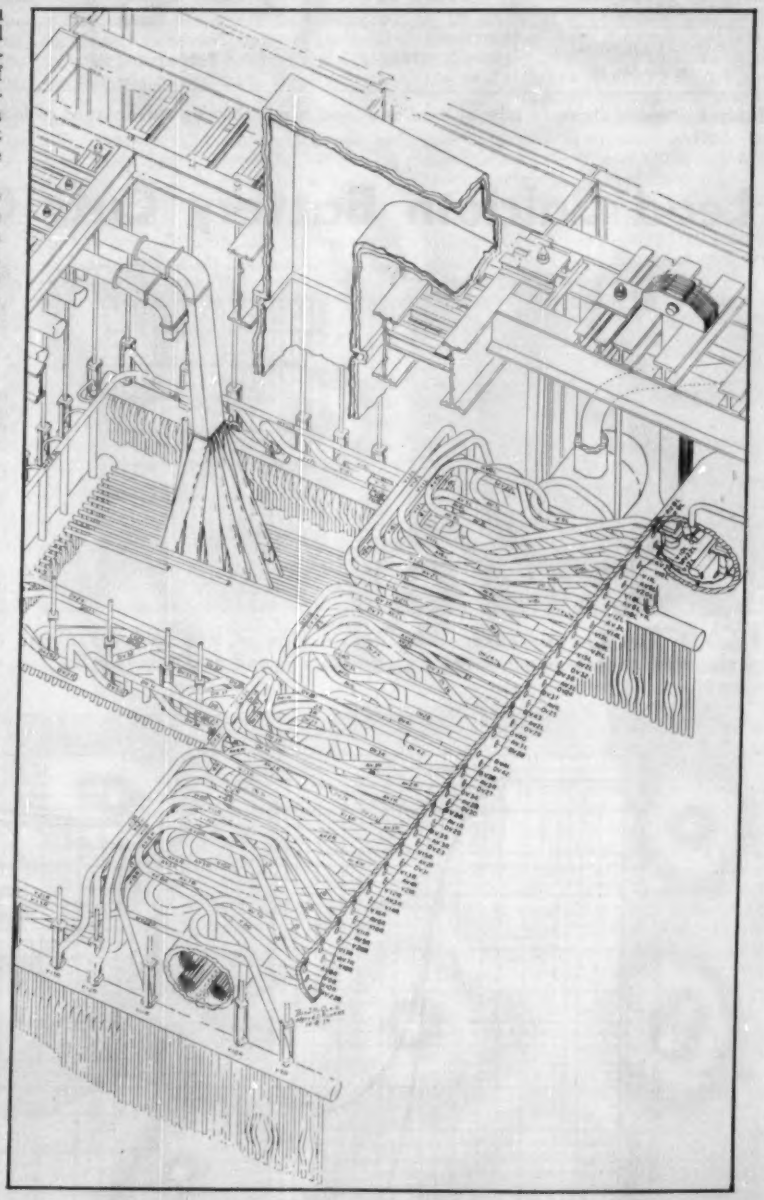
As soon as the boiler erectors saw these 3-D drawings, for the boiler shown here, they asked for them and used them in installing the tubes and drums. They reported that the 3-D's made everything easier for them and that every tube and part went into place with no interruptions and at great saving of time and effort.

Method of making these 3-dimensional scalable drawings has been developed by Dan J. McQuaid. There are two ways of doing it. One is with an Aerial-Vu projection machine on which plan, elevation and end view of a given object are mounted and, by means of a mechanical linkage, converted to a 3-dimensional drawing. Second method is by hand, using special drawing instruments available from the inventor.

With either method, the inventor states that no artistic ability is required. The drawings are designed to help construction workers or assembly workers in locating parts properly.

The method is used to make exploded views or assembly views of a machine or its parts, or of ductwork or piping, even before they are built, instead of making a model. It will show up mistakes or defects in design, interferences in piping and ductwork and the like.

They are not perspective type drawings; have no vanishing point, no converging lines, can be made as isometric, dimetric or trimetric projections, are accurately scalable. They are engineering drawings and not works of art.



Portion of Aerial-Vu 3-D drawing of upper parts of Boiler Unit No. 4 at Arapahoe Steam Electric Station of Public Service Co. of Colorado, supplied through courtesy of Robert F. Throne, chief mechanical engineer of that company

Unit is radiant type boiler, capacity 970,000 lb per hr. This portion shows sectionalized tubes, upper headers, attemperator and steam drums. Original was in pencil line on tracing paper. This drawing, only one of many being made for this and other units in Arapahoe, showing complete boilers, pulverizers and piping, ductwork, boiler feed pumps, flow sheet of water through heaters, automatic control features. They have saved on design and construction costs, will be used later in instruction manuals. The Arapahoe Station was designed and constructed by Ebasco Services, Inc.

For more information about the equipment and methods for making these Aerial-Vu 3-D drawings, write the Editor or jot 3-D DRAWINGS on the prepaid post card in this issue and mail it to us.

COMPOSITION	PURE LEAD[2]	7% ANTIMONY[2]	12% ANTIMONY[2]	0.085% CALCIUM[2]
MELTING POINT °F	621	532	485	620–623
DENSITY	11.34	10.81	10.45	11.34 (APPROXIMATELY)
RESISTIVITY 20°C OHM—CM.	21.2×10^{-6}	25.9×10^{-6}	28.9×10^{-6}	21.8×10^{-6}
TENSILE STRENGTH LB. per SQ. IN.	1780	7180	7480	7650

Table 1. Physical characteristics of lead and lead alloys showing advantages of lead calcium alloys over lead antimony

Lead Calcium Battery Cuts Control Costs

Fig. 1. Typical lead acid battery with grids constructed of lead antimony alloy

Fig. 2. View of lead antimony alloy grid for the lead-acid battery in Fig. 1.

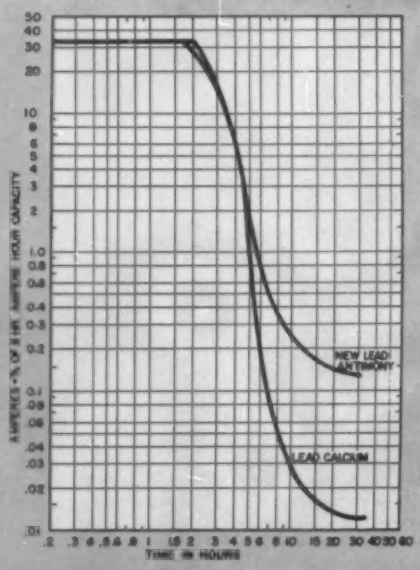
By HENRY E. JENSEN *

PERHAPS THE GREATEST single advancement in the lead acid storage battery field in the last generation has been the introduction of the lead calcium battery originally developed in 1932 by Bell Telephone Laboratories.

Since this date, many thousands of these cells have been constructed and are in use in full float stationary service, such as telephone and control.

Some of the advantages of this battery over the conventional lead antimony type are reduced over-all cost, longer life, negligible maintenance, less charge loss, less water addi-

* C & D Batteries Inc.



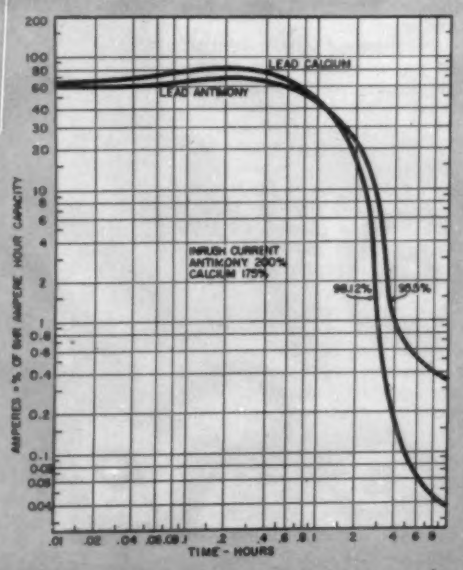


Fig. 3. Left. Charging lead calcium and lead antimony cells. Constant current to 2.3 v then constant potential at 2.3 v
Fig. 4. Right. Charging 100 per cent discharged lead calcium and lead antimony cells at constant potential of 2.37 v

tion (less than once a year in most installations), fewer equalizing charges, good cycle service operation, better charging characteristics and better all-round performance.

Such a list of advantages warrants a further look at this amazing battery, so here is a brief history of its construction and operating principles.

The name "lead calcium battery" is a misnomer in the same way that "lead antimony battery" is a misnomer. Both are lead acid batteries having the same basic chemical reactions, and the sole purpose of the calcium or the antimony is as an alloy with the lead used in the grid to harden and increase its tensile strength. Unfortunately, some alloying constituents, such as antimony, produce secondary chemical effects that cause undesirable secondary reactions and reduce the over-all performance of the battery. The merit of calcium is that it does not cause these limiting side reactions.

When lead acid batteries were first produced, pure lead was tried in the grids (i.e. the skeleton framework used to hold the active material). It was soon found, however, that pure lead was too soft and lacked the physical strength to produce a good battery. Alloying various other metals with lead was also tried, and it was found that antimony, in proportions from 4 to 12 per cent increased the tensile strength, and it has been used in most batteries ever since.

It was suspected, however, that antimony, being electro-positive to lead, would cause undesirable side reactions. Bell Telephone Laboratories undertook a research program to determine the nature of these side reactions and to see if they could be eliminated or retarded.

This work confirmed that antimony was dissolved from the positive grid and deposited on the active material of the negative plate. In addition, a local action occurred between this antimony and the sponge lead of the negative plate. Antimony on the negative plate causes a reduction in charging efficiency for two reasons: one, an increased rate of self-discharge occurs due to the local action on the plate, and two, the hydrogen over-voltage of the sponge lead is lowered. This lowering of the hydrogen over-voltage causes the cell to gas at a lower potential while on charge. These findings explain why the float-current needed to prevent self-discharge increases with the age of the cells. In addition, the removal of antimony from the positive plate hastens the breakup of the grid and shortens the life of the cell.

Now any other electro-positive-to-lead alloying constituent would have the same disadvantages, while electro-negative-to-lead materials that could be used as alloying agents have a greater tendency to be dissolved from the grid metal. Thus a satisfactory alloying material should be electro-negative-to-lead, and be present in a form in which it would not be readily available for solution.

The answer was found to be an alloy containing less than 0.1 per cent calcium. This compound is present as submicroscopic particles within the lead crystals, and is thus in a form in which it is not readily available for solution. Any exposed calcium immediately reacts with the electrolyte and is precipitated as calcium sulphate, leaving the lead calcium grid presenting a pure lead surface to the acid, and having electrochemical properties of pure lead.

From this description it is evident that the only physical difference between the lead calcium battery and the familiar lead antimony battery is the alloying constituent in the grids.

In physical appearance and basic construction the conventional lead antimony grid cell and the lead calcium grid cells are identical. Figs. 1 and 2 show a typical battery and one of its grids. The only difference between one battery and another is that one has grids made of lead antimony and the other grids of lead calcium.

Fig. 3 shows a typical recharge in which current is held constant until a voltage of 2.30 is reached and then this voltage is held constant and the current allowed to taper off.

Greater efficiency in charging is obtained from the lead calcium cells and is due entirely to the absence of the secondary reaction at the negative plate as shown by the value of current to which the cells dropped. It also explains why the loss of charge of the lead calcium cell on open circuit is almost negligible.

Fig. 4 shows a comparison of the various charging currents required to hold terminal voltages on the calcium lead as compared to new and old antimony lead cells, while Fig. 5 shows the charging characteristics of calcium lead cells and new antimony lead cells at 77F on a constant bus of 2.37 volts after 100 per cent discharge.

Many severe tests on lead calcium cells in cycle service having the same type plates as used in control cells have shown that these cells are completely suitable for cycle service, when properly made for such service.

It may justly be asked why these cells have not been widely used before. The reason is that the calcium lead cell is difficult to construct. One of the major advantages of the use of antimony in the antimony lead battery is its ability to produce clear sharp castings. Casting of calcium lead is very difficult and new methods have had to be developed. These are now available, and even though the cost of calcium lead cells is slightly more than that of pasted plate lead antimony cells, the over-all cost of using calcium lead cells is less than that paid for the best long-life batteries of other designs.

Much of the above information was presented in an AIEE Conference Paper entitled "The Lead Calcium Battery" by J. F. Rittenhouse and H. E. Jensen. Data on 7 and 12 per cent antimony in Fig. 1 is from a book "Storage Batteries" by G. W. Vinal, and the material on .085 per cent calcium is from a paper by Schumacher & Phipps of the Bell Telephone Laboratories which was published in the Transactions Electrochemical Society, 1935.

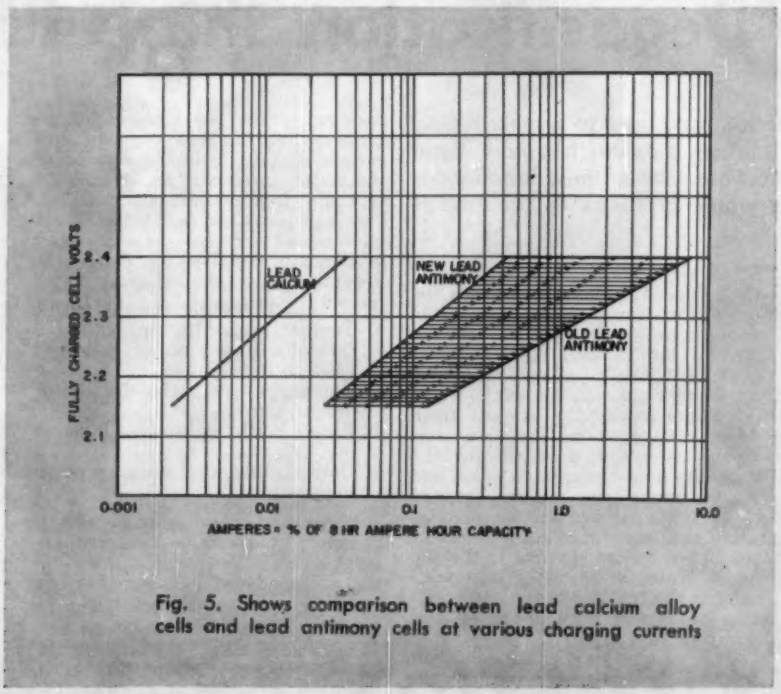


Fig. 5. Shows comparison between lead calcium alloy cells and lead antimony cells at various charging currents

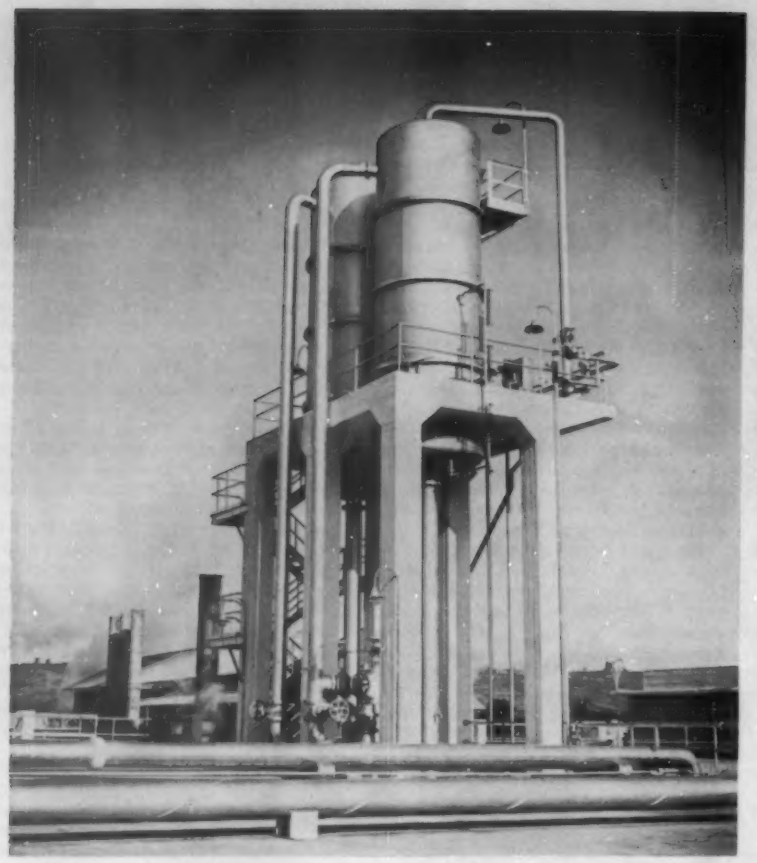


Fig. 1. Two 3000-gpm vacuum degasifiers installed by Mexican oil company to remove oxygen and carbon dioxide from water used to flood underground petroleum fields. Water for this purpose must contain no impurities, organic growths, or turbidity

Vacuum Degasification Shows Its

The principle of vacuum degasification, long used to protect piping from corrosion by oxygen and carbon dioxide, has now been extended to other industrial applications. Five of these installations are described. Have you similar water problems to be solved?

By ROBERT H. MARKS*

VACUUM DEGASIFIERS remove non-condensable gases from liquid. They were first used to remove oxygen and carbon dioxide from water to protect piping from corrosion. However, in recent years this equipment has been used for a variety of applications in the treatment of water for industry and industrial and public utility power plants. Following an outline of basic theory and operation, these applications will be described together with approximate equipment and operating cost.

Figure 2 is a line drawing of a Permutit vacuum degasifier illustrating the principal features of the design. Basically, it is a packed column used to carry out mass transfer between liquid and gas under vacuum conditions. The water is sprayed into the top of the degasifier shell and is distributed uniformly over the top surface of the packing. The packing, generally consisting of a stack of trays or raschig rings, subdivides the water flow and repeatedly exposes fresh water surface to the gaseous phase. As the water flows down through the unit, the non-condensable gases and water vapor are drawn upward through the packing and removed by vacuum pumps or steam jet ejectors through a baffled opening in the top head. Water is admitted automatically to the top as necessary to maintain the proper level in the effluent pump suction supply.

The continuous countercurrent flow of gas and water through the packing scrubs the dissolved non-condensables, such as oxygen and carbon dioxide, from the surface of the water, producing an effluent essentially free of non-condensables. Our pilot plant and field installations have established that the extent and efficiency of dissolved gas removal is dependent upon the following major factors:

1. Temperature of influent water,
2. Quantity and kind of dissolved gases to be removed,
3. Correct influent water distributor design,
4. Proper height and spacing of packing,
5. Correct capacity vacuum producing equipment.

Large capacity vacuum degasifiers generally use steam jet ejector equipment to maintain vacua and remove the non-condensable gases. For low water temperatures, three-stage ejectors with intercondensers are used because of their low steam consumption

* The Permutit Co.

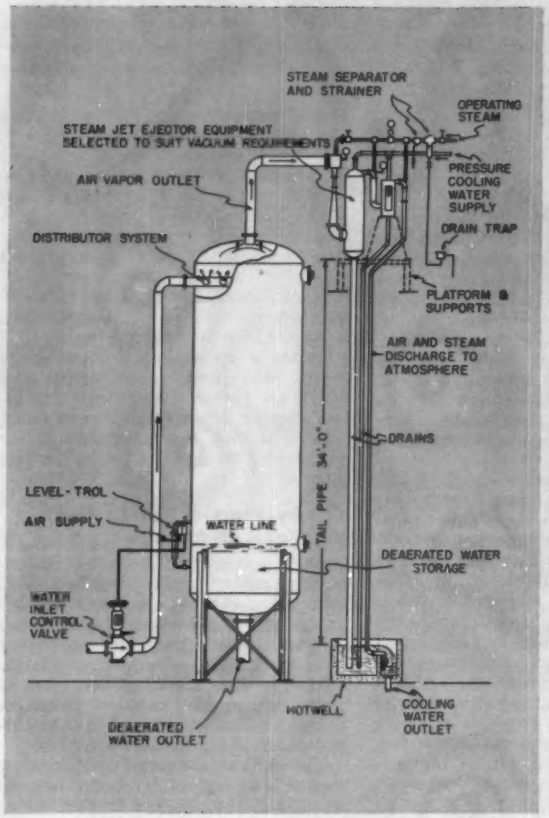


Fig. 2. Construction details of a typical vacuum degasifier

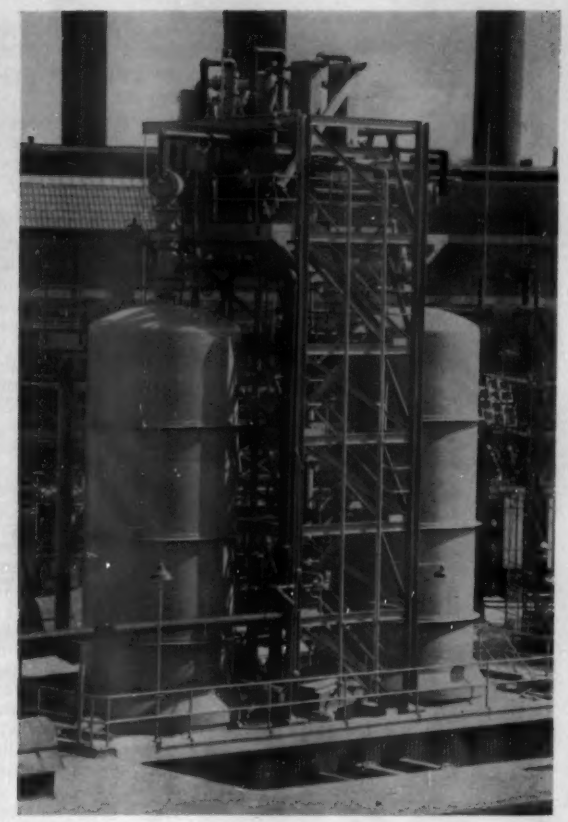


Fig. 3. Pair of 3500-gpm units operating at Louisiana utility

Versatility

as compared to single- and two-stage arrangements. For higher suction temperatures, single- or two-stage ejectors can be economically operated. For smaller capacities, where steam is not readily available, mechanical vacuum pumps are frequently substituted.

Recent applications of vacuum degasifier equipment in various plants include the treatment of:

a. Chemical plant cooling water,
b. Water for oil field flooding operations,
c. Boiler feedwater makeup for a by-product power plant,
d. Boiler feedwater makeup for a public utility power plant,
e. Cosmotron cooling water.

The approximate equipment cost for these installations is shown in Fig. 5. In general, the cost increases with flow rate but is of necessity directly affected by the design requirements for a particular installation. For this reason each proposed installation must be evaluated individually. Comparative operating cost for the

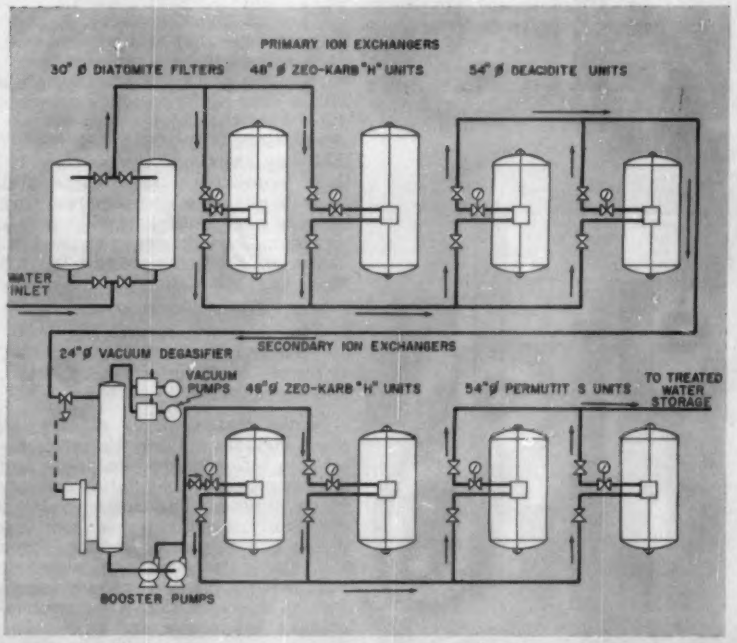
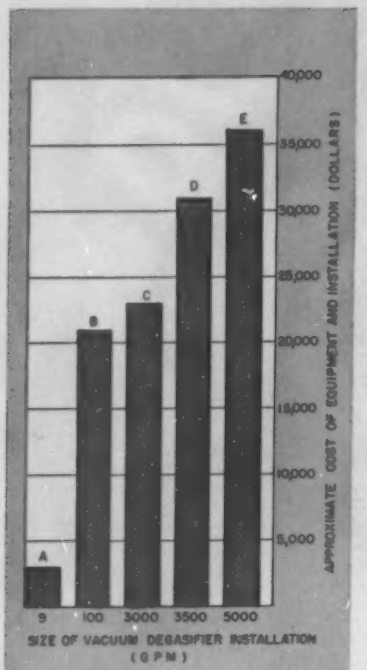
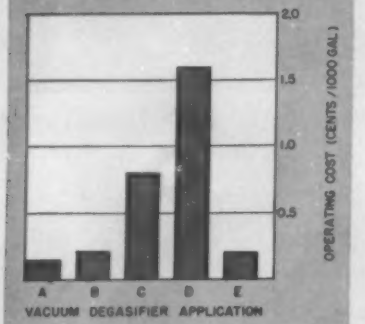


Fig. 4. Flow diagram of an automatic four-step dimineralizing and silica removal plant which serves two 1500-psi, 1000-F boilers at new installation for West Coast public utility. This equipment has reserve capacity for two additional boilers





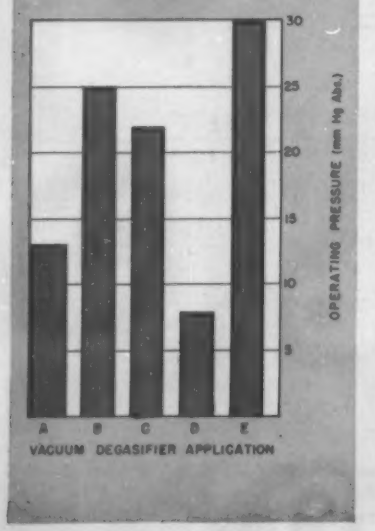


Fig. 5. (*Left, top*) Bar chart shows approximate equipment cost of plants described. Letters "A" to "E" identify plants (list, page 93). Fig. 6 (*left, center*) shows operating costs of the plants; Fig. 7 (*left, bottom*) gives range of operating pressures

vacuum producing equipment is illustrated in Fig. 6. The range of design operating pressures is given in Fig. 7.

Chemical Plant

Corrosion at this West Coast plant was severe enough to require a complete plant shut-down every three months for acidizing heat exchangers which had become badly tuberculated in this short time. The corrosion rate, due to the cooling water passing through their heat exchangers and steel distributing lines following, was great enough to require heat exchanger tube replacement every 18 to 24 months.

A vacuum degasifier was installed to remove oxygen and carbon dioxide from their cooling water. This equipment has a design capacity of 5000 gpm and is 11 ft in diameter by 34 ft straight height. The design includes packing of wood slat construction and a header-lateral inlet distributor system. The vacuum is maintained by three-stage steam jet ejectors with barometric intercondensers. Access to the jets is obtained by a set of ladders with safety cages.

This plant realized sufficient savings in heat exchanger tube replacement, acidizing expense, increased production and reduced water consumption to pay for the complete vacuum degasifier installation in less than one year.

Oil Company

When an oil well goes dry, some of the petroleum may still be recovered if the geological structure is favorable by flooding these fields with water. This is done by forcing high pressure water down through the porous strata of the earth. Any impurities present that may exert a clogging action on these pores are objectionable and must be removed, since the resulting increase in pressure loss will cause a corresponding decrease in water flow. The established requirements for this water are that it should be:

1. Free from turbidity,
2. Free from organic growths,
3. Free from iron and/or manganese,
4. Stable in chemical composition,
5. Non-corrosive.

Water treatment at a Mexican plant includes a Permutit precipitator complete with chemical feeds, and gravity filters for coagulation and turbidity removal. The treated water is chemically stable and free from turbidity and suspended matter. From the filter clear-well the water is pumped into the two vacuum degasifiers as shown in Fig. 1, for removal of dissolved oxygen and any carbon dioxide that is present. The deaerated water then flows by gravity into deaerated water storage before being pumped underground.

The vacuum degasifier minimizes corrosion of pumps and piping, thereby preventing pore clogging from corrosion products carried underground. In addition, the absence of oxygen prevents possible pore clogging due to the oxidation of any iron present in the underground strata.

Each degasifier tank is 8 ft in diameter by 25 ft straight height with a unit capacity of 3000 gpm. The vacuum is maintained by two-stage steam jet ejector equipment. The tanks are elevated sufficiently to allow gravity flow to the storage basin below. Notice the unique concrete supporting structure utilized for this purpose.

By-Product Power Plant

In terms of fuel cost per kilowatt hour of power produced, this Southern by-product power plant is a most economical steam power source. Low power cost is achieved by selling the turbine exhaust steam to neighboring industry instead of condensing it for return to the boiler as condensate. The heat in the exhaust steam is utilized instead of wasted in the cooling water of the surface condenser.

The exhaust steam sold to industry means that the boiler must receive essentially 100-per cent treated water makeup. The makeup water for this service must be completely demineralized and free of silica at the high boiler pressures utilized in this modern power plant.

Automatic demineralizing[1, 2] equipment was selected for this purpose and includes eight cation exchangers followed by two vacuum degasifiers and eight anion exchangers.

The vacuum degasifiers serve primarily as carbon dioxide removal units for the cation effluent water. Mechanical removal in this manner greatly reduces the chemical removal load of the anion exchangers which would otherwise do the job. As a result, the chemical operating cost of the anion units is considerably decreased. It is true that forced draft degasification equipment would serve this same purpose. However, the vacuum method was selected to avoid saturating the water with oxygen when removing the carbon dioxide.

Each vacuum unit has a capacity of 3500 gpm and is 10 ft in diameter by 34 ft high (units illustrated in Fig. 3). Interiors are lined with $\frac{3}{16}$ in. rubber and equipped with a header-lateral type inlet distributor system in stainless steel construction. The steam jet ejector evacuating equipment is located on the top of the structural steel platform between the vacuum vessels. The tower packing consists of raschig rings supported on stainless steel grating.

The steam jet ejector equipment is

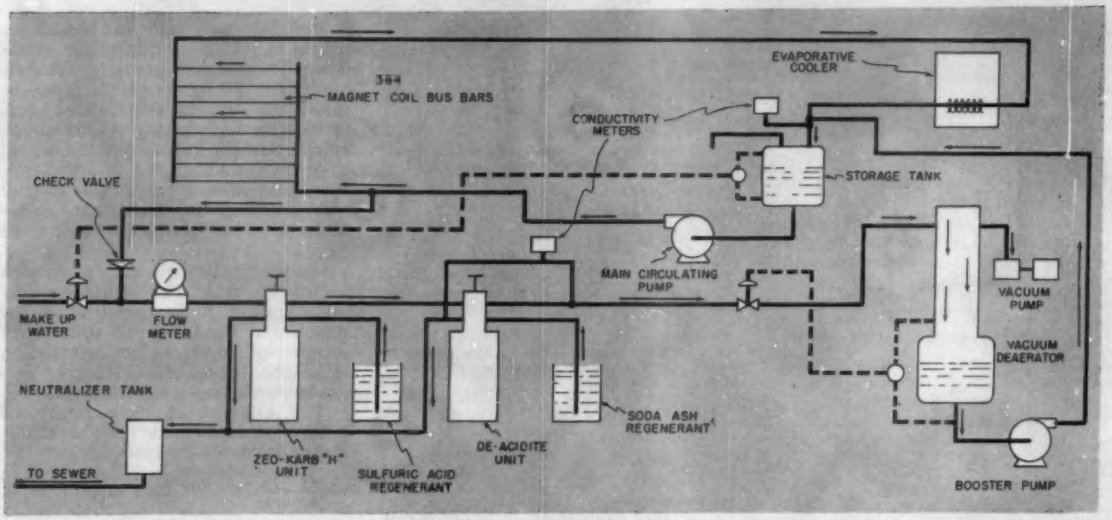


Fig. 8. Flow diagram of the demineralization system for Cosmotron cooling water at the Brookhaven National Laboratory

of the 3-stage type and is arranged so that either set of the ejector equipment can be used with either vacuum degasifier. In addition, both sets of evacuating equipment can operate on each vacuum tower. Because of the large cooling water flows, this water is reclaimed from the barometric intercondensers and returned to the cation inlet header for treatment in the demineralizing system.

Public Utility

The two 1500 psi, 1000 F boilers at this new West Coast installation are supplied with makeup water by a Permutit 4-step automatic demineralizing and silica removal plant.[2] Two additional boilers are also on order, which will operate at 1850 psi with initial and reheat temperatures of 1000 F. The final installation of four boilers will be capable of producing a total of 4,100,000 pounds per hour of steam. The water conditioning equipment (shown on the flow diagram in Fig. 4) will handle the makeup requirements of all four boilers.

This 4-step demineralizing plant was selected to achieve both high effluent water quality and low chemical operating cost. The primary stage cation units contain Zeo-Karb H material for efficient cation exchanger. The primary anion units contain De-Acidite, a weakly basic material which is most efficient for removal of sulphate and chloride anions. The vacuum degasifier is used to remove the carbon dioxide present in the first-stage effluent in order to reduce the chemical load on the secondary anion units. The secondary cation exchangers also contain Zeo-Karb H and are used to remove any metallic cations that slip through the primary unit. The secondary anion exchanger contains Permutit S and is primarily used to remove soluble silica. It also picks up any residual carbon dioxide, chlorides, and sulphates from the primary section of the demineralizing plant.

The vacuum degasifier for both oxygen and carbon dioxide removal has a capacity of 100 gpm and is 2 ft in diameter by 31 ft straight height. The vacuum tower is designed as an unguyed stack to meet earthquake load requirements. The interior is lined with rubber and contains ceramic raschig ring packing. Operating vacuum is maintained by 2 Kinney vacuum pumps taking suction through a connection on the top head of the tower. Both pumps are arranged to operate at low water temperatures to achieve efficient gas removal. At higher inlet water temperatures, one pump is shut off, since the remaining unit has sufficient capacity to maintain the required vacuum at this condition.

National Research Laboratory

The atom-smashing Cosmotron[4] at an East Coast laboratory employs a 1700-ton electromagnet. The magnet is formed in the shape of a doughnut with a 30-ft radius and has a C-shaped gap on the outer circumference where the protons travel during their acceleration. The magnetic coil consists of 384 water cooled copper bus bars, 50 ft long, with a cross-section 2¾ by ¾ in. The cooling water is circulated through an oval hole running longitudinally through each bus bar. Since the coil voltage is 3000 v, the cooling water must have a high electrical resistance to minimize leakage currents between the coil and the grounded water piping.

A Permutit demineralizing system provides cooling water with the required electrical resistance. Their well water is passed first through a Zeo-Karb H cation exchanger and then through an anion exchanger containing De-Acidite. Final treatment is given in a vacuum degasifier for oxygen and CO_2 removal to prevent corrosion of the bus bars in addition to further reducing the electrical conductivity.

The magnet cooling system is shown on the flow diagram in Fig. 8, and recirculates 500 gpm of demineralized water through the magnet coil and evaporative coolers. The demineralizing equipment is operated in parallel with the magnet coil and handles 9 gpm continuously. Makeup water to the entire system enters through the demineralizing units.

The vacuum degasifier consists of a 20-ft high raschig-ring packed tower mounted above a 100 gal. storage tank. The vacuum is maintained by a Beech-Russ vacuum pump raking suction from the spray compartment of the tower. The inlet system consists of a stainless steel water box with a spring-loaded spray valve for even distribution over the packing.

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3. Morris, Samuel B. "As Big as Hoover Dam," October, 1954, issue of the *American City*

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"You fightin' with your wife again?"

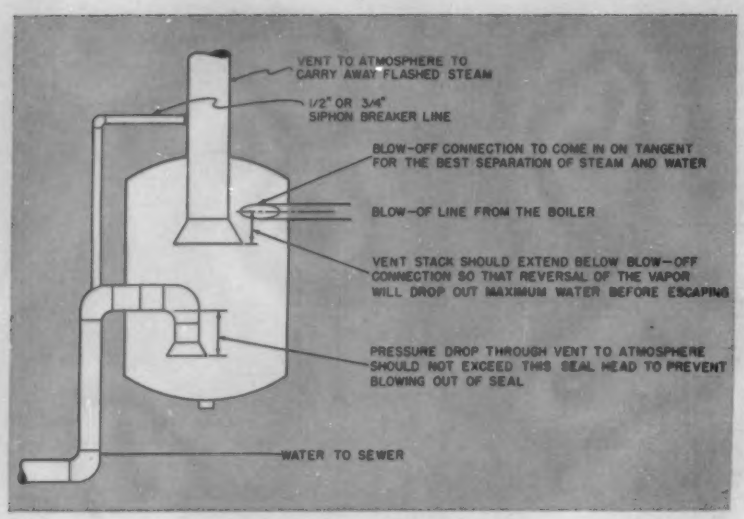

VENT TO ATMOSPHERE TO CARRY AWAY FLASHED STEAM
1/2" OR 3/4" SIPHON BREAKER LINE
BLOW-OFF CONNECTION TO COME IN ON TANGENT FOR THE BEST SEPARATION OF STEAM AND WATER
BLOW-OF LINE FROM THE BOILER
VENT STACK SHOULD EXTEND BELOW BLOW-OFF CONNECTION SO THAT REVERSAL OF THE VAPOR WILL DROP OUT MAXIMUM WATER BEFORE ESCAPING
PRESSURE DROP THROUGH VENT TO ATMOSPHERE SHOULD NOT EXCEED THIS SEAL HEAD TO PREVENT BLOWING OUT OF SEAL
WATER TO SEWER

Fig. 1. General arrangement of a typical blow-off tank and its pipe connections

How to Size Your Blow-off Tank Correctly

By FRANK M. KAMARCK

THE PURPOSE OF the blowdown tank is to cool boiler blowdown discharge to acceptable limits for discharge into the sewer system. This is accomplished by flashing the discharge in the tank and collecting the dropped-out condensate for wasting to the sewer.

The most important element in sizing the blowdown tank is the escape vent. The flashed steam must leave the tank without building up back pressure sufficient to blow out the water seal. If the tank vent is sized properly, and the seal pressure head is greater than the friction in the vent, no steam blow-out to the sewer will occur.

The blowdown tank also serves the purpose of dissipating the velocity pressure of the incoming blowdown mixture, and to shake out suspended water drops. The velocity head is dissipated by bringing the fluid to a stop in the direction of its travel. Fluid is brought in on the periphery of the tank and, being forced to follow the internal circumference, constantly changes direction. Since the flashed vapor turns inward toward the vent intake, suspended water drops down along the inside of the shell into the water reservoir below. The action is similar to that of the centrifugal separator.

A minimum of water should pass out of the vent with the steam, and the steam leaving the vent discharge should have as high a velocity as possible so that any condensation that occurs will be widely dispersed. However, inside the blowdown tank where the flashed steam is in contact with the water, and where it enters the vent inlet, its velocity should be as low as possible.

Entrainment of some water cannot be avoided without making the blowdown tank much larger and more elaborate than is practical. (For instance, witness the elaborate means used to prevent entrainment of water by steam leaving boiler steam drums.) On the other hand, it is desirable to keep entrained water to a reasonable minimum so that it does not become a nuisance to the plant by dropping out a shower from the vent outlet discharge.

The basic investigation that must be made in order to size and design the blowdown tank properly is to determine the amount of blowdown, the conditions under which the maximum rates of discharge will be encountered, and the rate at which it will reach the blowdown tank. The following factors should be investigated:

1. Conditions that will be present in bringing the boiler up to pressure. This will depend on the boiler design, the manufacturer's recommendations and the proven practice of the operators. This would be the amount necessary to flow through the superheater in order to prevent damage when bringing the boiler up to pressure.

2. Surface blowdown conditions. The amount of this blowdown might be large under some emergency situation where large amount of raw makeup might be necessary. This should be determined.

3. Sizing and run of blowdown piping handling the mud drum blowdown. This usually sets the maximum condition. A chart such as given in the Tube-Turn catalog can be used for estimating quickly the amount of the flashing mixture delivered to the blowdown tank.

Investigation of these three factors will establish the maximum water and vapor the blowdown tank is to handle.

Let us go through the design of a blowdown tank. For example, after investigation it is found that the maximum condition of blowdown for an industrial boiler installation is 12,000 lb per hr at 150 psig saturated water from the mud drum.

The amount of flash from one pound of blowdown can be determined from the expression:

$$x = \frac{h_1 - h_{f_2}}{h_{g_2} - h_{f_2}}$$

where:

x = amount of flash

h_1 = 338.54, the enthalpy of saturated water at 150 psig

h_{f_2} = 186.09, the enthalpy of saturated water at 16.7 psia

h_{g_2} = 1152.86, the enthalpy of saturated vapor at 16.7 psia,

and

v = 23.8 cu ft per lb, the specific volume of vapor at 16.7 psia, or,

= 26.8 cu ft per lb, the specific volume of vapor at 14.7 psia

We will do this for a 2-psig seal head, assuming that this is as high as we wish to go. Later, the key part that this decision plays in design of the blowdown tank will be evident. Substituting in the above expression, we have:

$$x = \frac{338.54 - 186.09}{1152.86 - 186.09} = 0.157 \text{ lb per lb blowdown,}$$

therefore:

flash = $0.157 \times 12{,}000 = 1884$ lb per hr

The 2-psig seal head determined the amount of flash, and it will also be important in sizing the vent. The seal head should be kept as low as possible since it will also determine the temperature of the water discharged from the blowdown tank to the sewer. Also, the height of the water seal leg will affect the over-all height of the blowdown tank. With a higher back pressure (higher seal head), the diameter of the vent pipe can be made smaller, and this may be desirable in some cases. However,

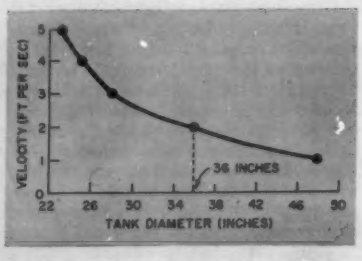


Fig. 2. Ratio of velocity to tank diameter. Note sharp rise below 36 inches

Staff Engineer, Burns and Roe, Inc.

it is generally more economical to buy larger standard pipe — if the run is not too long — than it is to fabricate a taller and heavier tank.

In this case, it has been decided to hold the back pressure in the blowdown tank to 2 psig. The vent pipe can be sized satisfactorily by an approximate, simple method by first establishing the limiting velocity possible for this pressure differential. From the expression $V = \sqrt{2gh}$, the following can be deduced for steam:

$$V = 223.7 \sqrt{\Delta H_s}$$

where:

V = velocity in ft/sec

ΔH_s = difference of enthalpy at constant entropy between initial and final pressure

From this we will calculate the velocity possible for an initial condition of 16.7 psia in the tank and a final condition of 14.7 psia at outlet of the vent:

$$q = \frac{S_g - S_f}{S_{fg}}$$

where:

q = quality of steam

S_g = entropy of saturated vapor at initial pressure

S_f = entropy of saturated liquid at final pressure

S_{fg} = entropy of evaporation at final pressure

and,

$\Delta H_s = H_1 - H_2$

$H_2 = h_f + q\, h_{fg}$

where:

h_f = enthalpy of saturated liquid at final pressure

h_{fg} = enthalpy of evaporation at final pressure

H_1 = enthalpy of vapor at initial pressure

H_2 = enthalpy of vapor at final pressure.

Substituting,

$$q = \frac{1.7463 - 0.3120}{1.4446} = 0.9929$$

$H_2 = 180.07 + (0.9929)\,(970.3) = 1143.48$, and

$\Delta H_s = 1152.9 - 1143.5 = 9.4$ Btu per lb converted to kinetic energy;

therefore,

$V = 223.7 \sqrt{9.4} = 687$ ft/sec.

The maximum velocity possible for the 2-psig pressure differential is 687 ft per sec no matter how the vent pipe is sized.

If about one half (1 psig) is allowed for kinetic energy, and the other half (1 psig) for friction in the vent pipe, then we can recalculate the limiting velocity, or approximate it: $0.7 \times 687 = 480$ ft per sec (since half the head will correspond to $\sqrt{\frac{1}{2}} = 0.7$ times the velocity).

Using 1 psig for friction pressure drop, we will try sizing the vent. Assuming 65 ft equivalent length of pipe (50 ft of straight pipe, plus 15 ft for entrance loss) the allowable loss per foot would be $1 \div 65 = 0.015$ lb per ft. Then, using a quick steam chart for pressure drop — such as that in Grinnell's *Piping Design and Engineering* — read off $3\frac{1}{2}$-in. pipe size for the pressure drop. To compensate for the approximations used, select the 4-in. size. Next, check velocity for a 4-in. pipe with the following velocity formula:

$$V = \frac{0.0509\, w\, \bar{v}}{D^2}$$

where:

w = lb per hr of steam

$\bar{v}$ = specific volume, cu ft per lb

D = ID of pipe, in inches.

Substituting,

$$V = \frac{0.0509 \times 1884 \times 26.80}{4 \times 4} =$$

161 ft per sec.

This velocity indicates that the 4-in. size is ample. It is obvious that considerably less than the 1 psig allowed for kinetic energy will be used with this pipe. The extra pressure available will be a factor of safety to take care of extra friction caused by entrained moisture going out the vent with the flashed steam.

Sizing Tank Diameter

The area around the vent pipe and inside of tank, and the area between the vent pipe inlet and the top of the water in the tank can be considered as passage area and not as volume for containment. If these areas are made sufficiently large to keep down the velocity of the vapor, the entrainment of moisture will be reduced.

Using 1 ft per sec for a first trial, and reworking the velocity formula in terms of area in square inches, A, results are as follows:

$$A = \frac{0.04\, w\, \bar{v}}{V}$$

Substituting,

$$A = \frac{(0.04)\,(1884)\,(23.8)}{1} = 1795 \text{ sq in}$$

Adding 54.43 sq in. to account for 8-in. entrance increaser (1795 + 54.43), we arrive at 1849.43 sq in. for the tank (for a velocity of 1 ft per sec). Sizes for other velocities are shown below:

2 ft/sec: A = 897.5 + 54.43 = 951.93 sq in.
3 ft/sec: A = 598.3 + 54.43 = 652.73 sq in.
4 ft/sec: A = 448.75 + 54.43 = 503.18 sq in.

Listed below are possible tank diameters with areas required for several velocities:

48-in. diameter = 1809.6 sq in.
36-in. diameter = 1017.9 sq in.
28-in. diameter = 615.75 sq in.
25-in. diameter = 490.87 sq in.

An examination of the possible tank diameters against velocities (Fig. 2) shows that the velocity goes up sharply below 36-in. diameter with little diameter decrease. So, for our example, we would choose 36 in. as the diameter of the blowdown tank.

Vent Height Above Water

The determining area will be the area of the surface of a cylinder with the diameter of the entering vent increaser. If a standard 4- by 8-in. reducer is used in order to keep the entrance velocity and entrance pressure drop down, then this area is: 3.1416×8 in. = 25.13 in., multiplied by the height above the water. To hold velocity entering the vent down to 1 ft per sec would require excessive height. If a velocity of about 4.5 ft per sec is used, the height will be about 16 in., and should be satisfactory.

Sizing Water Discharge Pipe

The amount of water to be handled will be the difference between the entering blowdown and flashed steam leaving the tank; i.e., 12,000 − 1884 = 10,116 lb per hr. This would be 21.2 gpm at 16.7 psia and 218.5 F. Referring to a pipe sizing chart, and using 2 ft per sec, this gives a 2-in. pipe size.

It is desirable to check the possible amount of flash that might pass to the sewer for water at this temperature under conditions where there is no other water flow to the sewer. In this case, using the formula previously given, the flash would be 62.5 lb per hr. This small amount of flash would normally be absorbed by other water flowing in the sewer line, or would pass out through the vacuum breaker line to the tank vent depending upon the pressure conditions.

Other Design Considerations

An impingement wear plate to take the erosive wear of the entering entrained blowdown mixture is also considered desirable (see Fig. 3).

The water seal leg should be supported with plate arranged in a manner to break up the swirling of water and to prevent a whirlpool from forming, with consequent blowthrough of steam.

A manhole is desirable above the water level for inspection and for possible repair purposes.

A drain at the bottom is necessary to eliminate bottom accumulation periodically.

Regarding the design pressure of the tank, if the maximum condition has been selected carefully, then only structural considerations need govern the thickness of the tank since the internal pressure is small.

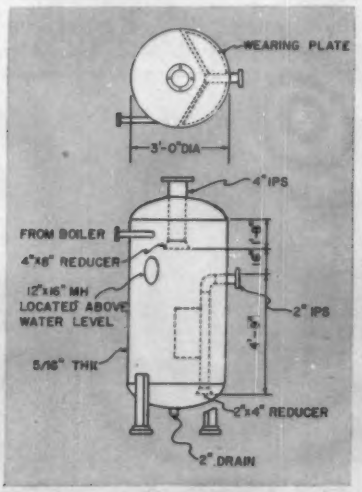


Fig. 3. Details of blow-off tank construction. Dimensions explained in text

Compare Your Outdoor Piping With This Job

These photographs of piping for a new 100,000 kw unit at Dallas Power & Light Company's Parkdale Plant show a good example of modern outdoor station construction and also a remarkably neat looking piping installation

Photographs courtesy Blaw-Knox Company

Fig. 1. Above. Shows one of the boiler feedwater pumps and some boiler feed piping. Pipe covering is aluminum

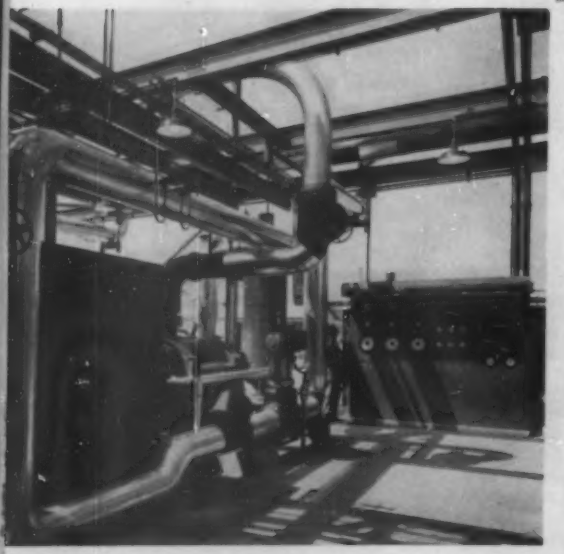


Fig. 2. Below. Outdoor control panel, located among boiler feed pump system, makes supervision more effective

Fig. 3. Above. Temporary construction sheds over turbine and generator. Crane will remain as permanent equipment

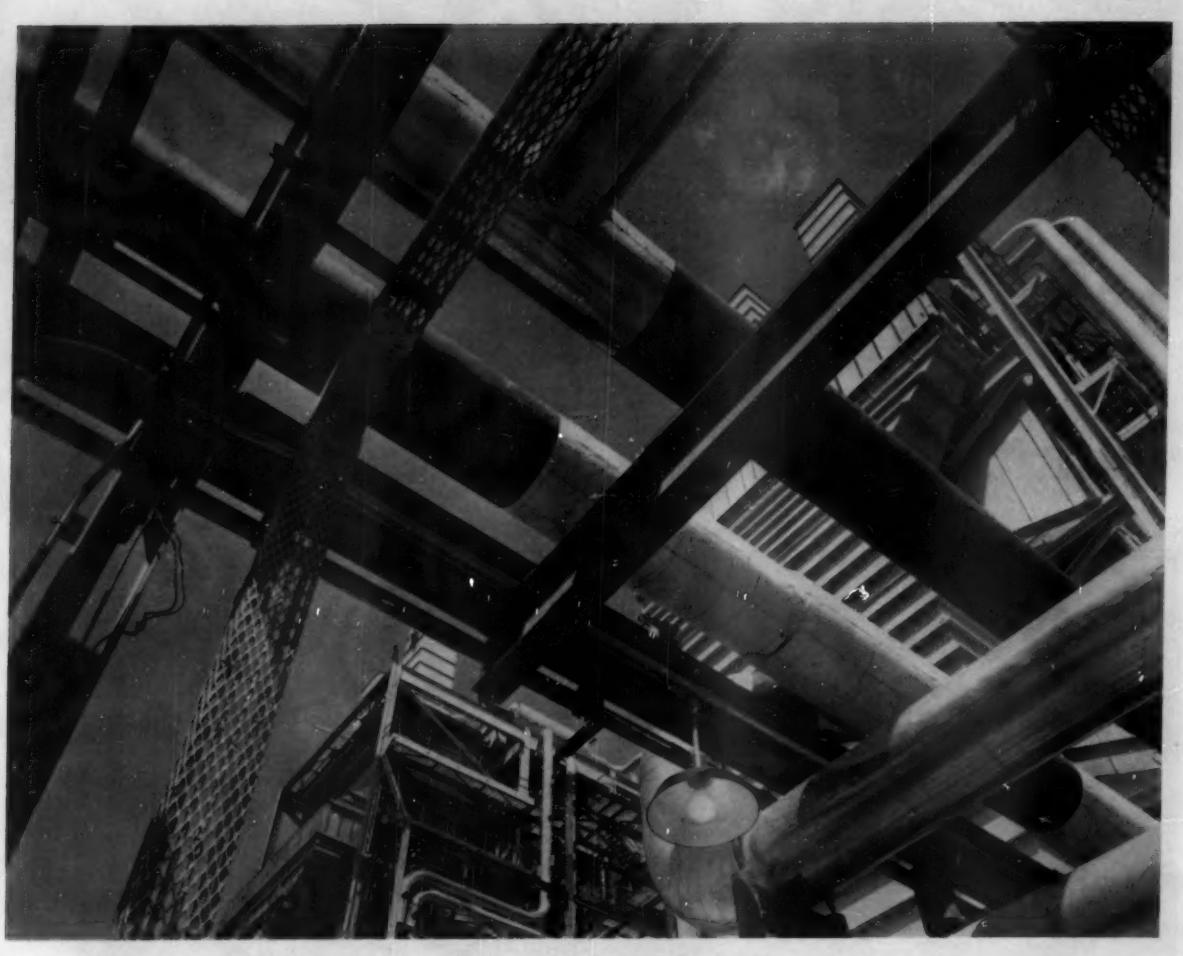


Fig. 4. Above. Piping during sheathing operation. Note expanded metal racks used to carry power and control cable

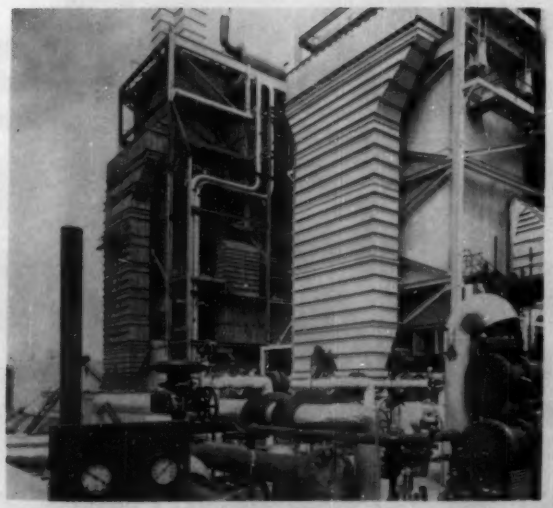


Fig. 5. Above. New 100,000 kw unit at left, existing unit at right. Steam conditions are 1550 psi and 1005 F temp.

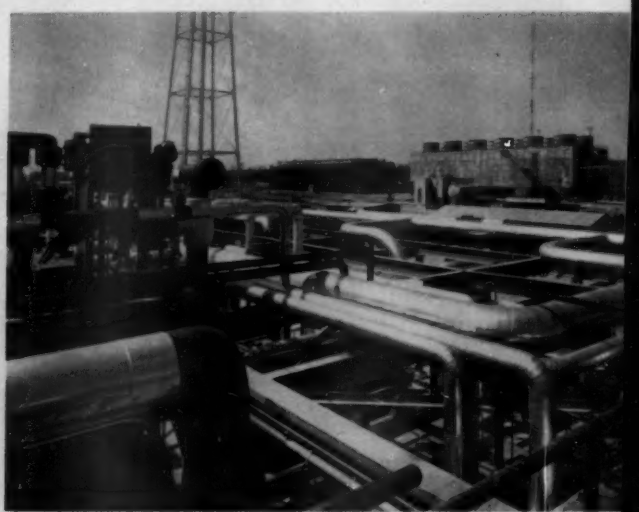


Fig. 6. Above. Construction photo showing cooling towers in background. Tower at left only partially completed

What Engineers Are Doing Six to

	6 TO 10 YEARS SINCE GRADUATION	11 TO 15 YEARS SINCE GRADUATION	16 TO 20 YEARS SINCE GRADUATION	21 TO 30 YEARS SINCE GRADUATION
DESIGN	37%	29%	26%	20%
ADMINISTRATION & MANAGEMENT	9%	19%	32%	48%
MILITARY	1%	4%	3%	3%
NON-ENGINEERING	5%	6%	3%	5%
SALES	6%	9%	5%	3%
RESEARCH & TEACHING	10%	9%	7%	7%
OPERATION	32%	24%	24%	14%

Tabulation of occupations vs. field of engineering, U. of California, for all ages

Kind of Work	Per Cent Engaged in Each Kind of Work					
	All	Civil	Electrical	Mechanical	Mineral	Other
Operations & Design	57	69	53	48	66	58
Admin. & Management	21	17	22	24	16	10
Sales	6	1	7	10	7	7
Research	5	1	9	7	3	7
Teaching	4	4	3	4	2	8
Non-Engineering	5	4	4	5	5	10
Military	2	4	2	2	1	0
	100	100	100	100	100	100

Thirty Years After Graduation

University of California keeps tabs on its engineering graduates and what they have done for laughs (groceries, rent, etc.) after graduation. So, they conducted a survey. Here are thought-provoking results, adapted from a report in the *California Monthly*

MOST ENGINEERING schools care very little what happens to their graduates after they are sheepskinned and the school has helped them find that first job. The University of California, however, was sufficiently curious to run a little survey and find out.

Questions they asked determined occupations by age (that is, years out of college) and, of course, the over-all percentage in each of seven categories regardless of age. To make the survey cover all the numerous branches of engineering, they made the categories general: i.e., design, administration and management, military, non-engineering, sales, research and teaching, and operation.

As might be expected, the number of graduates in administration and management increases gradually from 9 per cent (6- to 10-year group) to 48 per cent (21- to 30-year group). The number in design diminishes consistently from 37 per cent (6- to 10-year group) to 20 per cent (21- to 30-year group). Other details of the breakdown are shown on preceding page.

General Types of Work

Another interesting breakdown is given in the table on this page. This table reports the general type of work being done by California engineering graduates in all age groups and in each of the major engineering branches. Mechanical and electrical engineering report the highest percentage engaged in administration and management, mechanical engineering has the largest percentage in sales, electrical engineering has the highest percentage in research, and civil and mineral engineering have the highest percentage engaged in operation and design. It should not be surprising that civil engineering reports the highest percentage in military work.

One might ask why the survey concerns itself only with those graduates who made the grade six or more years ago. Actually, the University of California keeps very close tabs on its recent graduates, but they were not considered in the studies of careers because of the misleading effects of military conscription and graduate study. For example, the class of 1954 boasted 288 engineers; statistics are available on 258 of them. Out of the 258, 165 were employed, 58 were in military service, 32 were doing graduate study, 3 were not employed.

Careers Emerge

After a few years, careers begin to emerge from this welter of diverse activity. Graduates begin to work into the categories plotted on the opposite page and (statistically) a rather regular and predictable pattern develops. One of the areas requiring most study is that described as "administration and management." We must realize that attaining this category does not necessarily imply success as an engineer, but merely the development of a different specialty within their field of engineering.

For many excellent engineers, reaching the management specialty (we do not like the tag "management level") is entirely possible but would be a professional mistake. The problems of engineering, however difficult, are problems involving tangible factors in varying numbers and combinations. Management problems are exercises in intangibles such as human emotions, plain old politics, economics, market surveys, salary evaluation, recruiting, and so on. Outstanding ability in systems engineering, for example, would not necessarily imply ability in *any* of these management functions, much less all of them. Even if ability is present, the engineer must be interested in more than the title involved to become a good administrator.

Teaching and Research

It is rather interesting to note the consistent percentage of graduates employed in teaching and research. The over-all average, regardless of age group, is nine per cent. This over-all average compares with 10 per cent in the 6- to 10-year group, 9 per cent in the 11- to 15-year group, 7 per cent in the 16- to 20-year group, and 7 per cent in the 21- to 30-year group. The implication is that such occupations have little turnover or little shifting in and out of other engineering fields as men grow older.

Finally, California's survey dispelled (to a great extent) one of the nation's most popular misconceptions — that employers fought grimly among themselves for the privilege of paying new graduates $500 and more a month. While it is true that nearly all graduates had jobs before they actually graduated, the average price tag was $366 per month. Some of the colleges in the East have reported an average starting salary in excess of $400, but even this will not permit the graduate with a family to relax his vigil over the dollar. And despite the good times being had by all, it is likely that the graduate engineer will acquire family expenses more rapidly than he can acquire the income to meet them.

Caster-Trolleys Move Equipment

By C. SHAFF American Broach and Machine Co.

IN THE normal course of maintaining and modifying a plant, heavy equipment is moved to and from the shops, from the unloading platform to its foundations, or to one side to allow removal of other machines. The traditional method of moving machines which cannot be reached by the crane is to set them on rollers and "inch them along."

Our shop has a great deal of this to do, but we found that rollers or reinforcing rod lead to a slow and cumbersome operation. We made up a number of small platforms of heavy steel deck plate (see illustrations) and mounted them on heavy-duty steel casters. Each caster runs on ball bearings and also swivels on ball bearings. We attached hand-holds to each end of each connected pair of platforms so that steering can be by hand or by tow-ropes.

When the "trolleys" are assembled and set as shown in Fig. 1, the overall height from the floor is only four inches.

Fig. 1. Rugged little platform on wheels is not pretty, but can carry 10-ton load around corners

Each assembly can support 10 tons, and greater loads are possible by using multiple trolleys.

It is no longer necessary to scotch-and-snatch equipment to turn corners or jockey it into position since the swivelled wheels will follow any direction of travel. Time savings are obvious.

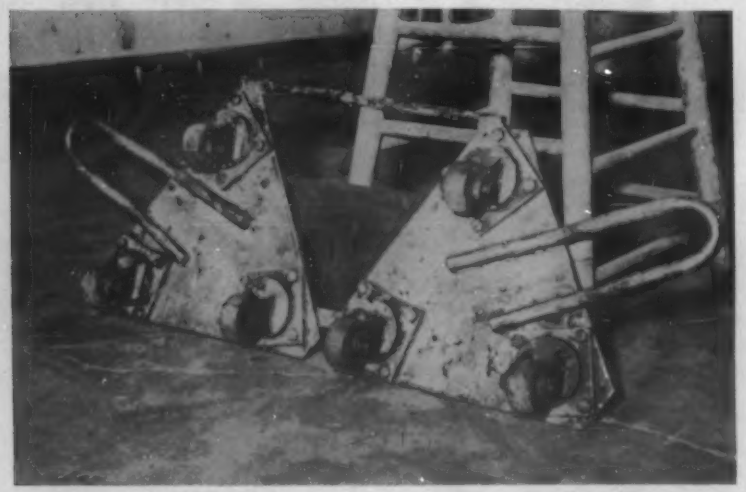
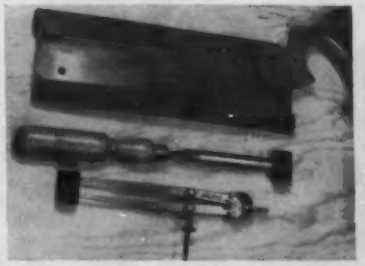


Fig. 2. Triangular plates of steel decking mount rugged casters at each point. Hand-holds allow a fore-and-aft pull to turn corners. The flat type of construction increases its stability and safety when loaded

Simple-But-Handy Uses for Scrap Rubber

By F. E. RILEY



Edge-protectors made of split rubber hose work on wood chisels, saws, dividers, or any other of the sharp-edged tools. Protectors are especially valuable if tools are kept in tool boxes. Many dangerous cuts can be avoided if they are used

Wrap-around rubber bumpers are secured with rubber cement, are made of rubber bands from inner tubes. They protect portable power tools against breakage when dropped, protect soft alloys against abrasion. Leave the vents open

Outlet for Overhead Bus Duct is Simple, Safe

By C. SHAFF

Head of extension rod is standard overhead duct plug, clamped and taped to the six-foot wooden rod. Length of the rod depends on floor clearance

POWER tools are a great convenience in any maintenance operation, unless long and dangerous extension cables are needed. Our plant solved this problem partially by installing universal bus duct overhead throughout the shops. Until recently, however, the men had to climb a ladder to plug into this duct. This was slow and dangerous.

To speed up the operation and avoid such an obvious accident-trap, we made up a number of plug extensions (see photos). These consist of six-foot wooden rods with cable running the full length. At one end is a simple socket outlet, and at the other is a standard plug which fits the overhead bus duct. When a man wants to use a power tool near any part of the overhead duct, he merely stands below it and plugs in the rod assembly. Usually this is close enough to where he wants to work that it is not necessary to use an extension cable to connect his power tool.

We have been using these devices long enough to prove their effectiveness and convenience.

BETZ • *A Great Name In Water Conditioning*

Welcome visitor...

The Betz District Engineer is a welcome visitor wherever he goes. As our personal representative to industrial plants, petroleum installations, institutions . . . plants like yours, he plays an all-important role in our continuing efforts to engineer *controlled* water conditioning.

His job carries many responsibilities. For example, he

. . . instructs your plant operators in Betz-engineered water conditioning control techniques (chemical feed, water testing, chemical adjustment, blowdown control, etc.).

. . . makes regularly scheduled visits to your plant to review operating conditions.

. . . reviews plant control and offers "on-the-spot" constructive criticism and advice.

. . . checks testing procedures, test solutions and chemical feed equipment.

. . . inspects plant equipment and visually observes the results obtained.

. . . discusses any and all water problems with you and your operating personnel.

. . . prepares and submits a complete written report before leaving your plant.

And equally important, he works closely with the Betz headquarters engineering staff to assure the individual attention required for sound, economical water conditioning.

Next time a Betz District Engineer calls, ask him to explain how Betz *completely-integrated* water conditioning service can obtain results in *your* plant. He'll be happy to give you the details.

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BETZ

CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

For more data circle 545 on Post Card

Boiler Water Supply Primer

By P. J. GROGAN *

PROBLEMS of boiler water supply will be treated here from two aspects. First, a bit of information about the various waters available in nature. We depend upon such waters as a primary source for all boiler water. Secondly, a discussion of the characteristics of return condensate which comprises the bulk of water injected into boilers. Blending and modification of the chemical nature of both waters will be discussed. Consideration will also be given to use of the boiler as a controlled reacting vessel in internal treatment methods.

Using Water Wisely

Nature has been most kind in giving us a compound so plentiful and so useful as water. Responsibility for leadership in the sound use of water rests generally with those of us whose livelihood depends upon a continued reliable supply. The more we learn about water, the better we will be able to use it. The better we use it, the greater our dividends, both immediate and in the future.

The cycle in which water moves is extremely complex. The demands which our industrial civilization are imposing upon that cycle are staggering to the imagination. Small wonder that temporary dislocations and imbalance of supply and demand are exceptions rather than the rule. Such occurrences are likely to be more prevalent in the future than they have in the past. Accordingly, any contemplated expansion or new construction should be preceded by a competent water survey. Certainly one of the most desirable characteristics of a boiler water supply is *water*, itself. Hasty or ill-advised decisions with respect to a new or increased supply can easily lead to operating difficulties in meeting an anticipated new output. It very well might cause a complete loss of production.

A look at the future for factors influencing each source of supply is worthwhile. In making a survey be sure that all possible sources are being considered. And in making an economic selection, be sure that all hidden costs are being considered. Important as supply may be, *quality* probably outranks *quantity* where boiler water is concerned. Remember, some treatment is certain to be required. The form of treatment varies with water chemistry. It is very difficult to train technicians to prescribe treatment for a grossly different water analysis every time it is repeated. It follows, then, that a source yielding a nearly constant analysis has certain advantages over a source subject to seasonal or periodic variations of considerable magnitude.

Attributes of Surface Waters

A plant location on or near a river practically assures a supply of moderately soft water. River waters normally contain a considerable amount of suspended matter, organic substance, and to a lesser extent, dissolved solids. Pumping equipment for river water is relatively easy to establish and to maintain. The problem of handling flood stages will have to be worked out in the general scheme of plant location. Also, severe droughts may reduce the river flow to a fraction of its normal amount. While water undoubtedly will be present for makeup purposes, its chemistry may change radically during such times. Similarly, the turbidity and hardness will change with the seasons, the nature of runoff from the drainage basin, and with the stage of stream flow.

Water discharged to the river by an upstream plant can have a bearing upon its usefulness to you as a source of boiler water supply. While there is ever-increasing legislation against stream pollution, litigation is slow and costly in terms of the results obtained. Industrial establishments generally prefer to resolve such matters within the brotherhood of business rather than resorting to the processes of law. Moreover, you may have to learn to live with a pollution problem if the effulents of upstream plants are within the legal limits on the statutes. Your treatment program will have to be adjusted to cope with each pollutant added to the stream.

Pretreatment of river water requires particular attention to the mechanical methods of *settling*, *filtering*, and *coagulation* by flocs. In addition, *deaeration* and *softening* will be required.

It may actually prove cheaper in many instances to pump water from a more distant lake than to use a badly polluted nearby river or one with a history of floods and droughts. Lakes often serve as natural settling basins and the water chemistry changes less rapidly. Seasonal variations of turbidity and dissolved solids content are predictable. The organic matter in certain lakes may run to rather high counts with seasonal variations. A population of microorganisms is common. Large lakes, such as the Great Lakes chain, offer a very dependable source of makeup feed water from the point of view of water chemistry. Smaller lakes are subject to noticeable pollution which varies with the seasons and the rotation of crop land within the drainage basin. Access to certain small lakes may be difficult due to private or municipal control of the shore line. Other problems are presented by seasonal temperature changes and possible solid freezing in our northern latitudes.

Attributes of Ground Water

Well waters run fairly constant with respect to temperature and to composition. The higher level of dissolved solids shifts pretreatment emphasis to the reduction of hardness by chemical precipitation, ion exchange, or distillation. A properly-driven well will produce water relatively free from contamination by suspended solids and organic matter. Color, taste, and odor are outward signs of probable dissolved impurities other than the normal salts. Aeration and special forms of treatment may be required.

Advantages of a private well as a source of boiler water supply are significant. There is a high degree of flexibility with respect to location and to operation. There are real advantages in having a relatively constant temperature and composition of raw water. Dissolved gases and suspended matter will be at low levels. Organic matter and micro-organisms will be practically nonexistent.

Locating a well requires some exercise of forethought and good judgment. The choice of site should be based upon known geological and hydrological data. Test bores can confirm or deny the opinion with respect to the underground structure. The type of well construction should take into account the probable depth, rate of pumping, and ultimate uses. The requirements for a drinking water supply are considerably more rigid with respect to possible sources of contamination than they are for strictly industrial purposes.

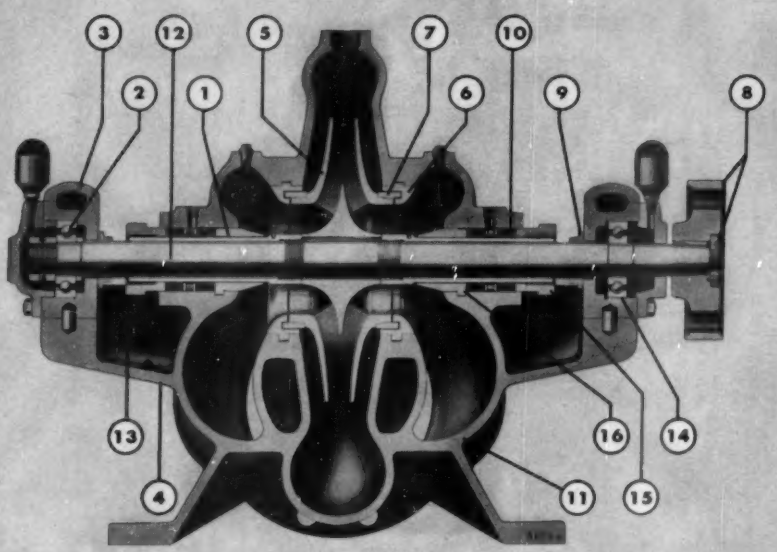
While ground water levels are generally subsiding, skill and ability in the construction and operation of wells is increasing rapidly. Both chemical and mechanical techniques are available for producing satisfactory yield from new wells and for rejuvenating faltering or abandoned wells.

Requirements for feedwater in most plants are not of sufficient magnitude to necessitate an independent source of supply. Certainly, there should be no objection to using the normal municipal drinking water supply. Cost of the raw water is a negligible factor. However, treatment will probably be cheaper if a lake or river source can be obtained.

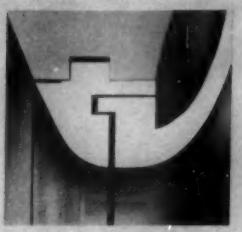
* Chairman, Department of Engineering, University Extension Division, University of Wisconsin.

DE LAVAL
SINGLE STAGE CENTRIFUGAL PUMPS

for dependable industrial service



Labyrinth wearing rings minimize leakage...maintain high efficiencies



Labyrinth rings used in these De Laval pumps retard flow of water through labyrinth passage.

Flat rings showing relatively unimpeded flow of water.

① **Shaft Sleeves** are screwed on, to abut the impeller and make a water-tight joint. Sleeve expands freely and independently of shaft when temperatures change. There is no tendency to buckle.

② **Thrust Bearing** locates rotor axially.

③ **Bearing Caps** easily removable for maintenance.

④ **Bearing Brackets** scraped to lining bars for perfect alignment.

⑤ **Impeller** hydraulically balanced, finished on all surfaces.

⑥ **Labyrinth Wearing Rings** held accurately in machined grooves in both case and cover.

⑦ **Impeller Wearing Rings** threaded on impeller, opposite to rotation.

⑧ **Flexible Coupling** ground on all exposed surfaces and statically balanced, complete coupling supplied, pump half mounted on taper so that it can be easily removed. Check nut locks coupling on taper.

⑨ **Deflector** keeps water out of bearing.

⑩ **Stuffing Boxes** extra deep; lantern rings for water sealing.

⑪ **Pump Case** horizontally split; machined to limit gages.

⑫ **Steel Shaft** ground to limit gages.

⑬ **Drip Boxes** large; provided with drain openings.

⑭ **Radial Bearing** free to move axially, thus avoiding temperature strains.

⑮ **Glands** split horizontally.

⑯ **Protecting Bushings** renewable.

You can count on the performance of the De Laval Single Stage Centrifugal Pumps because they are precision-made to high manufacturing standards and incorporate the many quality design features shown in the cross-section.

They operate at high or low speeds, at high or low heads...with maximum efficiency.

For example, De Laval G, I and K Single Stage Double Suction Pumps have a capacity range of 175 gpm to 6,000 gpm, and heads to 300 feet. They are available in sizes ranging from 4" suction and 3" discharge to 14" suction and 12" discharge. Write for Bulletin 1002.

DeLaval also furnishes larger centrifugals for capacities up to 70,000 gpm. Bulletin 83-29R sent on request.

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Condensing plants almost always depend upon such media for cooling water purposes. It follows, then, that most operations will draw upon those waters for makeup purposes.

Setting Up a Water Treatment Program

The problem of supplying a suitable feedwater for a boiler will vary from installation to installation. In any event, it is influenced by some or all of the following variables:

A. Type of steam generating equipment
B. Application for which steam is made
C. Load variations and peak ratings experienced
D. Required purity of steam leaving the boiler drum
E. Protection of other components around the cycle
F. Contaminates in the return condensate
G. Per cent makeup feedwater required
H. Available sources of makeup feedwater.

While the objective of any water treatment program is easy to describe — a clean, trouble free system — practically no two units present the same set of initial conditions. Therefore, it is necessary to analyze each case separately in terms of the above outline of variables before making recommendations relative to the application and use of treatment methods.

Boiler Types and Applications

Steam boilers may be classified various ways. The following grouping is merely suggestive of significant differences among designs. Pressure and capacity increase generally with increasing classification number.

1. Horizontal return tubular — fire tube boilers
2. Package boilers — either fire tube or water tube
3. Straight tube boilers — cross or longitudinal drum
4. Low-head bent tube boilers — cross or longitudinal drum
5. High-head bent tube boilers — multiple drums
6. Integral furnace boilers — extensive waterwall surfaces
7. Central station boilers — radiant surfaces, open passes
8. Super-critical pressure boilers — forced circulation.

Many other individual boiler characteristics have not been indicated. To name but a few: riveted or welded construction; single or multiple drums; single or multiple pass; parallel or cross baffled; welded or mechanical joints; drum internals; superheat; separate or integral economizer; blowdown outlets. Experience and judgment indicate what to look for and what importance to assign each item. The general boiler classifications above are the principal guide posts inasmuch as they give clues to the internal circulation patterns, the preferred method of introducing internal treatment, the location of blowdown outlets, and the probable conditions of boiler service.

Steam boilers are generally employed for heating, process, or power. All possible combinations of the above are frequently encountered. Each application has particular attributes which affect the water treatment program.

1. Heating: A heating boiler probably enjoys a fairly high per cent return condensate. Corrosion of return lines may be aggravated by CO_2. Air will undoubtedly be associated with return water, necessitating effective deaeration. Daily and seasonal peaks will depart radically from the average rating. Banking may be practiced commonly. Generally good availability for maintenance. System often rundown and neglected. Instrumentation and supervision often poor to fair.

2. Process: A process load may be a highly variable load. Condensate return may be low or nonexistent. Return may be highly contaminated. Steam for process may require high degree of purity. There may be seasonal peak and slack periods; otherwise weekend maintenance may be necessary. May be banked frequently. Instrumentation and supervision probably fair to good.

3. Power: A power load is generally subject to gradual load variations over the complete operating range of boiler capacity. There is a high per cent of condensate returned in excellent condition. High availability of unit must be assured by good water treatment. Low steam contamination permitted when superheating. Little time for maintenance. Practically no unscheduled maintenance. Generally good to excellent instrumentation and supervision.

4. Combinations: Here are established the greatest range of operating variables. Difficult to establish averages. Generally one application will predominate. Above general conclusions will then have to be adjusted to take into account side influences of other applications.

Objectives of Water Treatment

The purposes in conditioning boiler water by external, internal, or a combination of methods are to establish and maintain clean surfaces throughout the boiler interior; protect against general corrosion, pitting, and inter-crystalline cracking; and to deliver clean dry steam from the drum outlet at whatever desired rate. This should be accomplished while holding the blowdown to an economical per cent of boiler feed.

Scale control probably represents the most important function of any water treatment program. The accumulation of scale deposits on the boiler heating surface can reduce efficiency through poor heat transfer and result in tube metal damage or failure through overheating. External treatment processes generally remove most of the scale-forming calcium and magnesium compounds. The nature and amount of pretreatment will depend upon the mineral content of the makeup water supply.

Scale deposits on boiler heating surfaces fall into two ready classifications. They may be deposited directly to the metal molecule by molecule or they may settle as a sludge and be baked onto the metal surface. Scale formed by direct deposition on the heating surface is serious because of its hard, tight bond. It has a high insulation effect which greatly increases tube metal temperature. Such scale is not easily removed.

Scale forming salts decrease in solubility with increasing temperature. The higher the boiler operating pressure, the higher the saturation temperature, and the more insoluble certain calcium and magnesium salts become. This imposes several restrictions upon the allowable content of such compounds in high pressure boiler units. A thin scale formation could cause sudden tube failure due to higher initial stresses coupled with higher initial tube metal temperature.

Logically, the hottest water in a boiler system is found at the hottest tube metal surface. It is there that the flint hard scale tends to attach itself. This may occur in the lower part of the circulation system near an area of close flame impingement. A hydrostatic head of several pounds per square inch is superimposed on the boiler operating pressure in such regions and the saturation temperature is proportionately higher. Salts which tend to become insoluble are precipitated at such a point. Other areas of deposition are where evaporation rates are high. Rapid loss of water through evaporation will create local high concentrations of dissolved impurities and precipitation follows. Nature is generally kind to us by presenting many self-regulating systems. However, there are systems which tend to hasten toward self-destruction once they begin. The minute spots of scale drive the metal temperature higher at each point. The higher metal temperature under the scale conducts outward radially and the spot both grows and thickens until corrected treatment or failure intervenes.

Allis-Chalmers Supplementary Treatment

Eliminates All Scale!

Call on ALLIS-CHALMERS for Water Conditioning

WATER SOFTENING PLANTS SELDOM REMOVE all scale-forming material. In fact, only one part per million of hardness in feedwater will amount to twenty pounds of scale or sludge after twenty million pounds of steam is generated. In even a short period, this build-up can cause serious trouble. In addition, condensate is frequently contaminated.

To solve this problem, Allis-Chalmers has developed its supplementary treatments, which are formulated specifically to the requirements of individual plants.

You can find out about factors involved in designing the proper supplementary treatment in Allis-Chalmers Water Conditioning Informational Bulletin 52. It explains how Allis-Chalmers water conditioning engineers approach this problem. Get a copy from your nearby A-C office or write Allis-Chalmers, Milwaukee 1, Wis.

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WATER CONDITIONING—CHEMICALS, EQUIPMENT, SERVICE—FOR OVER 25 YEARS

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Mechanical attachment of scale results when suspended solids bake onto the metal surfaces. This occurs in locations of poor circulation and during periods of banking or low-load operation. Internal conditioners can be used which will maintain the precipitating solids in a non-crystalline state.

Internal treatment preparations normally contain various inorganic chemicals which are designed to precipitate calcium and magnesium salts in a desirable soft-scaling form. In addition, a sludge conditioner such as tannin or lignin is used for the purpose of maintaining a suspended or non-adherent form of precipitate. Phosphate compounds are generally employed for the complete and efficient precipitation of calcium and magnesium salts for boiler pressures above 150 psig. A choice of phosphate may be made in line with the desired alkalinity to be maintained in the boiler and with the characteristics of the available feedwater supply.

The reactions in Table I indicate the various chemicals involved in hardness reduction and alkalinity adjustment through the use of phosphates. Boiler water reactions involving phosphates are based on the trisodium variety since the normal boiler water alkalinity first converts all phosphates to that form.

Normally, it is desirable to provide for the precipitation of magnesium as magnesium hydroxide or magnesium silicate. Magnesium phosphate may be considered as a less desirable type of suspended matter. Since properly adjusted boiler waters normally contain an appreciable amount of hydroxide alkalinity, and since the hydroxide is one of the least soluble compounds of magnesium, it is precipitated for the most part in the desirable hydroxide form. It is necessary to maintain the pH of boiler water above 9.5 to assure complete precipitation of magnesium in the hydroxide form. In high pressure work, when high magnesium is present, it may be better to use a deficiency of phosphate treatment to prevent the formation of magnesium phosphate.

Table II.

Phosphate reactions of Ca and Mg salts

$$CaCO_3 + 2Na_3PO_4 \rightarrow Ca_3(PO_4)_2 + 3Na_2CO_3$$
$$3CaSO_4 + 2Na_3PO_4 \rightarrow Ca_3(PO_4)_2 + 3Na_2SO_4$$
$$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3 + Na_2SO_4$$
$$3MgCO_3 + 2Na_3PO_4 \rightarrow Mg_3(PO_4)_2 + 3Na_2CO_3$$
$$MgCO_3 + 2NaOH \rightarrow Mg(OH)_2 + Na_2CO_3$$

The last equation in Table II suggests the natural method of magnesium removal so long as excess alkalinity is present.

Silica, if present in appreciable amounts in the boiler feedwater, may give rise to the formation of objectionable deposits. Calcium and magnesium combine with silica to produce complex silicates which produce extremely hard deposits which are very difficult to remove. Silica may seek out minute traces of aluminum to form complex compounds of difficult nature in high pressure boilers. Finally, silica may carry over with superheated steam to precipitate in a given section of the turbine causing imbalance and loss of efficiency. The prevention of silica scale in high pressure work is mainly a matter of silica removal by pretreatment. In some cases, good control is obtained by maintaining high phosphate excesses, together with high alkalinity.

Table I. Reactions involved in hardness reduction and the adjustment of alkalinity of boiler waters

Polyphosphate + Water = Monosodium phosphate
$$NaPO_3 + H_2O = NaH_2PO_4$$

Monosodium phosphate + Sodium hydroxide = Trisodium phosphate + Water
$$NaH_2PO_4 + NaOH = Na_3PO_4 + 2H_2O$$

Disodium phosphate + Sodium hydroxide = Trisodium phosphate + Water
$$Na_2HPO_4 + NaOH = Na_3PO_4 + H_2O$$

fold along this line — outside edges toward you

Corrosion

The corrosion of internal boiler surfaces is largely due to the presence of dissolved gases in the feedwater. Oxygen is particularly active in causing pitting corrosion when released within the boiler. Carbon dioxide and ammonia play lesser roles in boiler corrosion but may cause trouble elsewhere in the steam cycle.

Each of the above gases has a solubility characteristic in water which varies with the fluid temperature and the partial pressure of that gas above the fluid. The deaerating heater employs this principal by continuously removing the concentration of gases above the liquid while it is held at or near the boiling temperature for the pressure of operation. The oxygen content of water can be caused to approach the vanishing point by holding the liquid close to the boiling point while the evolved gases are swept away. Residual traces of oxygen can be removed from the boiler proper by the direct feed of a scavenger such as sodium sulfite. The reaction is:

$$2Na_2SO_3 + O_2 \rightarrow 2NaSO_4$$

This process is relatively inefficient since some eight pounds of sodium sulfite are required to remove one pound of oxygen. The nine pounds total then adds to the weight of dissolved solids in the boiler. Dosage of sodium sulfite may be estimated from the following approximate proportion: *Each part of dissolved oxygen per 1000 parts of water (by volume) requires a corresponding number of pounds of sodium sulfite per 10,000 gallons of boiler feed.* This method of estimating results in an approximate six per cent excess of sodium sulfite for a given dissolved oxygen content.

Acid corrosion is not likely to occur in a boiler proper. Boiler water alkalinity is almost positively assured under most treatment programs. Conditions of pH between 9.5 and 11.0 are common in boiler practice. Carbon dioxide, therefore, is largely suppressed insofar as corrosive action is concerned in the boiler. Considerable carbon dioxide may be evolved in the boiler due to breakdown of bicarbonates and carbonates. Once out in the system, where protective alkalinities are not maintained, carbon dioxide can cause extensive general corrosion damage. This is the particular problem of central heating plants with extended return line systems.

Boiler corrosion may occur by electrolysis in rare instances of mismatching metals or electrical coupling with some stray source of electron flow.

Caustic Embrittlement

Caustic embrittlement is a popular misnomer for a form of inter-crystalline cracking induced by stress and abnormal boiler water concentrations. These conditions are commonly fulfilled at riveted seams and rolled joints. The metal is easily overstressed at such points and undetected leaks may cause a gradual buildup of dissolved solids to very high levels approaching 100,000 to 500,000 parts per million. The attack along the grain boundaries is generally attributed to high concentrations of sodium hydroxide.

Early researches suggested the maintenance of two or three parts sodium sulphate per part of sodium carbonate in the boiler water. Later researches point to additional helpful inhibitors such as lignins, tannates, other organic compounds, as well as sodium chloride and nitrate.

The most effective protection against caustic embrittlement is the elimination of overstressed areas and minute leaks. Welded construction and seal welding of rolled joints have done much toward the reduction of these two contributing factors.

Steam Contamination

Steam generated in the boiler tubes is delivered to the upper drum in a torrent of water, foam, and sludge. The drum and its internals function to separate the steam from the liquid and suspended impurities. The process of such separation is carried out in several stages and may have its origin in the generating section of a well-designed boiler.

Several terms are commonly used in a discussion of steam contamination.

Water and Water Treatment
Section 13

NEW Silco-Flex MOTOR INSULATION

Offers These Amazing Physical Properties

● **Flexibility and Resilience** — *Silco-Flex* insulation remains flexible and resilient indefinitely. It is especially resistant to mechanical abuse and to stresses of overloading, rapid starting and stopping.

● **Moisture Resistance** — Completely sealed, *Silco-Flex* insulated coils are the most moisture-resistant commercial coils ever produced. They are production-tested while submerged in water . . . by far the most complete and searching high potential test used.

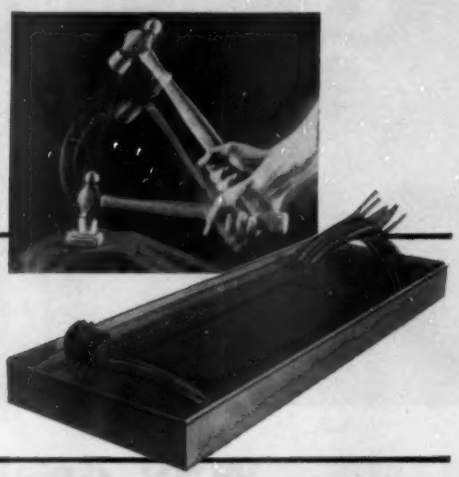
● **Abrasion Resistance** — Samples of insulation at right show effects after sandblasting with 90 grit aluminum oxide and 100 psi air for one minute. Nozzle-to-sample distance was six inches, thickness equivalent to 2300-volt insulation. Note difference in abrasion!

● **Homogeneity** — *Silco-Flex* insulation is a void-free dielectric barrier vulcanized into a unified insulating wall. It maintains its homogeneity under extremes of differential expansion and contraction due to thermal cycling.

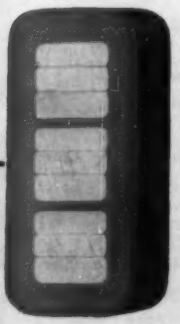
Other Advantages include exceptionally good thermal stability and chemical inertness. *Silco-Flex* insulation is also a much better heat conductor than ordinary electrical insulating materials. Moreover, enclosures now required to protect windings from moisture and abrasion may be eliminated in many cases.

Allis-Chalmers, working with Dow Corning Corporation, has developed *Silco-Flex* motor and generator insulation . . . truly new in concept . . . truly new in effectiveness.

Silco-Flex insulation employs a pure silicone rubber combined with specially developed application techniques to produce an insulation unmatched by any other in use today.



Silco-Flex Insulation | Polyester Mica Tape | Asphaltum Mica Tape



New *Silco-Flex* insulation is immediately available for all Class H form-wound coils and for Class A and B windings operating under selected service conditions. For complete information, call your Allis-Chalmers representative or write Allis-Chalmers, Milwaukee 1, Wisconsin.

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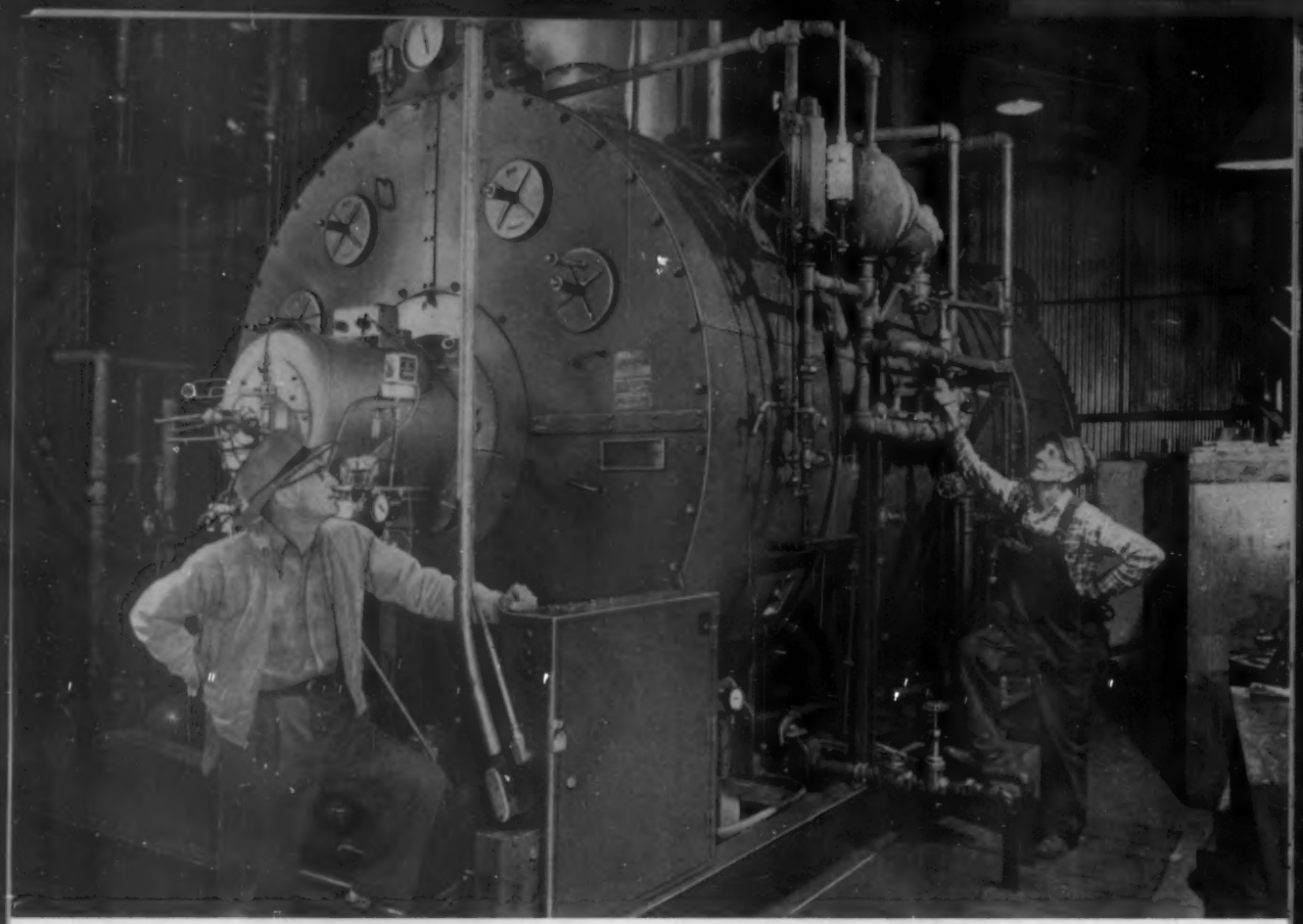

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This 500 HP *Powermaster* Packaged Automatic Boiler installed in a West Coast food processing plant has led to the purchase of four *Powermaster* units by other companies in the same area.

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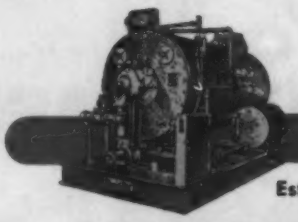

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tion of soluble salts in the boiler as follows:

$$\text{Salts in blr} = \frac{(\text{Chlorides in blr}) \times (\text{Salts in fw})}{(\text{Chlorides in fw})}$$

Internal treatment chemicals may introduce a small error, but the method offers certain ease and accuracy not always found in cumulative methods of determining total dissolved solids content.

Levels of concentration for suspended matter have been set by the A.B.M.A. standards. Blowdown offers a measure of control, but does not alter the ratio of suspended matter to dissolved solids. It is the responsibility of management, supervisory, and operating personnel to establish and maintain a mechanically clean supply of water.

A Look Ahead

Silica carryover with steam is one of the real problems associated with high pressure boilers due to its increased solubility in the steam. Control by blowdown is expensive. Control with magnesium is possible if a low phosphate balance is maintained. External forms of silica reduction will be employed more extensively in the future.

Sodium sulfite is unstable at high boiler pressures. External methods of reduction of oxygen to near zero levels must be assured for future high pressures and temperatures.

A potassium phosphate equilibrium may be used in some future designs due to its better solubility characteristics than sodium phosphate. However, lower excesses of phosphate radical are required with better control.

Permissible levels of sludge materials and total dissolved solids are decreasing. Future once-through forced circulation boiler designs will require feedwater with vanishing levels of all such impurities.

There is some factor of safety in pH levels of 10 and 11, when a pH of 9 might serve a particular boiler unit. However, the protection of one number on the pH scale affords a ten times excess of caustic radical to offset corrosion due to any incipient oxygen attack.

Steam purity is currently very nearly perfect. Continued stringent demands will be placed upon maintaining and improving these good records. Certain deliberate additives may be used to counteract the irreducible minimum of steam impurities. Other additives may be required for corrosion protection in the condensate return system. Already today's condensate of high purity affords little protection against various forms of attack upon the metal conduits through which it travels.

It is interesting to speculate about the nearly absolute purity of water required for tomorrow's forced circulation designs. The willingness of various alloys of iron to go into solution with water is not expected to change. Oxygen scavenging and induced alkalinity will still be required. Both treatment methods require chemicals as vehicles for creating a protective influence. Yet such chemicals must be classed as undesirable impurities in a system which evaporates 100 per cent of its feedwater without recirculation, storage, or blowdown. This problem is not yet solved.

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Carryover, *foaming*, *priming*, and the more recently coined *foamover* are some of the expressions which are used. *Carryover* is a general term that includes all forms of steam contamination by boiler water or its dissolved and suspended matter. The amount of carryover may be a negligible trace in a well-run boiler installation to excessive and troublesome amounts to be described under *foaming* and *priming* conditions.

There are several factors which can contribute to carryover. The principal divisions of carryover are spray in the form of foam or in slugs of water. Listed as causes of carryover are:

1) Capacity factors leading to priming
   a. load swings
   b. overloads
2) Design factors leading to foaming and priming
   a. circulation patterns
   b. disengagement area
   c. number of drums
   d. steam release space
3) Water level control
   a. column height
   b. rate of change
4) Boiler water impurities
   a. concentration
   b. composition
5) Drum internals
   a. design
   b. arrangement
   c. tightness
   d. cleanliness
6) Operating conditions
   a. pressure
   b. local velocities
7) Operating procedures
   a. control
   b. supervision

Priming is a term applied to any unusual or excessive carryover of boiler water into the superheater or steam main. Its cause generally lies in some mechanical condition or malpractice. It can be caused by a very high water level in the drum or by surging and swelling of the water during sudden changes in rating or pressure. Marine boilers are subject to priming by the pitching and rolling of the vessel in the seas. During priming, sizeable slugs of water are carried out of the drum with the steam.

Foaming is the result of a chemical condition of the water which causes bubbles to form and resist rupture. Delivered to the steam drum through normal circulation patterns, the bubbles may fill the entire steam space and work through the drum internals to be carried out with the entrapped steam. *Foamover* is intended to describe that aggravated condition. Some *foaming* without foamover can be expected at all times. Foaming is attributable to the presence of oil, organic matter, suspended matter, or the concentration and combination of dissolved matter and solids.

The American Boiler Manufacturers Association have agreed upon standards of boiler water concentration and per cent alkalinity for various pressure ranges. These standards are purely arbitrary, but serve as usual maximum levels for which the industry need design their steam purification apparatus unless a customer requests a change.

Oil contamination of boiler water may lead to metal failure through direct coating, which prevents wetting or through agglomeration of sludge and scale which then adheres to the surface. Oil enters the feedwater primarily through the exhaust condensate from engines and pumps.

External control procedures involve the use of an oil-absorbing floc, such as aluminum or iron hydroxides. Removal then is accomplished by filtering. Where the amount of oil-contaminated water is small — say, from a single pump or engine — it may be better to discharge the water to the sewer than to risk contamination of an entire boiler system.

Oil in boiler water should be kept to an

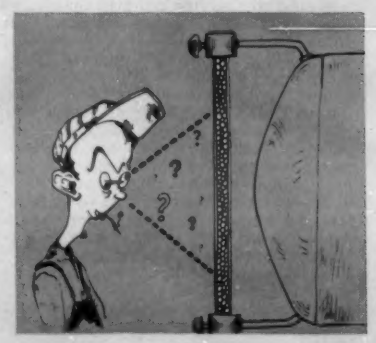

Table III. 1946 American Boiler Manufacturers' Association standards with interpretations by author

Pressure, psi	Total Solids, ppm	Suspended Solids, ppm	Alkalinity, ppm	Approximate pH
0– 300	3500	167	700	10.85
301– 450	3000	143	600	10.77
451– 600	2500	119	500	10.70
601– 750	2000	95	400	10.60
751– 900	1500	71	300	10.48
901–1000	1250	60	250	10.35
1001–1500	1000	48	200	10.30

Oil or grease that can be extracted by sulphuric ether or chloroform not to exceed 7 parts per million.

absolute minimum. No method of internal treatment can cope with the problem with assured success. Oil should be removed externally before it enters the boiler.

Blowdown

The term blowdown refers to the practice of discharging a portion of the boiler water and replacing it with makeup feedwater as a means of controlling boiler water concentrations. Boiler blowdown is generally expressed as a per cent of the boiler feed. Since the purpose of boiler blowdown is to maintain a constant level of dissolved solids, relatively few pounds of boiler water will remove all of the solids introduced by 100 pounds of makeup feed. Therefore, per cent blowdown commonly ranges from a fraction of a per cent to several per cent. The exact figure depends upon the feedwater characteristics, boiler design, internal treatment, momentary load and capacity ratings.

Sound engineering requires that blowdown should be the minimum consistent with the maintenance of a given level of dissolved solids. Taking the blowdown from a point of abnormally high concentrations will effect a reduction of per cent blowdown while accomplishing the desired reduction of solids content. Inherent with blowdown are losses of water (negligible), chemicals (marginal), and heat units (significant). Part of the water can be returned to the system by recovering the vapor which flashes from the boiler water under reduced pressure. The thermal energy is often conserved by routing continuous blowdown through a heat exchanger. The normal excess alkalinity in boiler water can be conserved by routing the flashed liquid to the hot process lime and soda softener. Intermittent blowdown may be used where little or no effort is made to conserve the potential contained in the discharged water.

Continuous methods of blowdown have become almost standard for all high pressure boilers and new construction of intermediate pressures. Continuous blowdowns should be located to blow down boiler water which has been circulated and steamed heavily. Such water will be higher in impurities, and less must be blown down.

A bottom blowdown or sludge blowdown is necessary for the operation of a boiler despite the presence of a continuous blowdown system. The bottom blowdown take-off is usually located low in the boiler circulation system, such as the mud drum of a Sterling-type boiler.

Recirculation Systems

There is a very material difference between the chemical nature of the feedwater and the boiler water. Corrosion protection of feed heaters, feed pipe and fittings, and the economizer may become necessary. This can be done by re-injecting a small amount of relatively high alkalinity boiler water into the feedwater supply. Reinjection may be made at the softening system, just before the feed pump, or between the feed pump and the boiler.

Hot process lime-soda softeners may require as much as 10 per cent boiler blowdown for operation. In the process, the pH of the feedwater is automatically increased to safe levels. In other systems, one to two per cent of the boiler water is sufficient to offer satisfactory protection against corrosion. This may be done by returning a small portion of the alkaline boiler water from the continuous blowdown line to the boiler feed line.

A Boiler Water Specification

The overall task of boiler water conditioning consists of maintaining the proper proportions of chemicals, the proper conditions of alkalinity, and the proper total salt concentration for the prevention of scale formation, corrosion, carryover, and caustic embrittlement. This conforms identically with the objectives of a feedwater conditioning program. While the main task of water conditioning should be performed outside the boiler, final control depends upon a knowledge of boiler water conditions and a prescription for each item which falls outside the control range.

Most softening systems do not produce zero hardness effluents. Also, no condensate return system is 100 per cent effective. Some chemicals must be added to the boiler to offset the hardness which inevitably enters the boiler.

Boiler water conditioning involves control of the following items:

1. Alkalinity
2. Softening agents
3. Oxygen scavengers
4. Silica
5. Sulphate
6. Chlorides
7. Suspended matter
8. Total concentration.

Control of alkalinity requires the determination of the three radicals; carbonate, $(CO_3)^{--}$; hydroxide, $(OH)^{-}$; and phosphate, $(PO_4)^{---}$. The upper limit of alkalinity is generally 20 per cent of the total dissolved salt concentration. The hydroxide alkalinity should be kept at a concentration to yield a pH of approximately 10.5. Internal phosphate treatment can be used very nicely to control the alkalinity. Trisodium phosphate is used to increase alkalinity. Disodium phosphate, monosodium phosphate, or even phosphoric acid may be used to decrease alkalinity. Sulphuric acid also may be used at some intermediate stage to reduce high alkalinity resulting from pretreatment of some waters.

The internal softening agent most commonly used for pressures above 250 psig is one of the phosphate compounds. Phosphate concentration, measured as $(PO_4)^{---}$, is effective in producing complete softening if maintained at 30 to 40 parts per million. This contrasts with a sodium carbonate requirement of $\frac{1}{8}$ to $\frac{1}{6}$ the sulphate — the larger fraction at higher pressures — which may require excesses of several hundred parts per million. Meanwhile, continual breakdown of the carbonate tends to produce excess alkalinity and to require more carbonate for the softening action.

The oxygen scavenger in most common use is sodium sulfite. A concentration of the radical $(SO_3)^{--}$ in the range 5 to 10 parts per million is effective in keeping the oxygen content sufficiently low to prevent internal corrosion. Present day feedwater concentrations of less than 0.005 cc per liter help minimize the oxygen corrosion problem.

Silica, SiO_2, is mostly undesirable in boiler water. Maximum concentrations are generally regulated to five to ten parts per million in high pressure boilers, perhaps a little higher for intermediate and lower pressures. Since control of silica concentration is accomplished through blowdown, its concentration in the feedwater is generally under one part per million so that excessive blowdown will not be required. Silica may serve a purpose in some waters as precipitant for magnesium. Magnesium phosphate does not produce a desirable sludge. There is generally enough silica present naturally for such purposes, although instances of deliberate silica additions are on record.

The concentration of sulphates was once watched closely for its protection against caustic embrittlement. Fabrication practices do not require that general protection today. Furthermore, the role of sulphate in protection against inter-crystalline cracking is now questioned. Where a phosphate equilibrium is maintained for softening action, the sulphate concentration need not be maintained above its natural level.

Chlorides serve little useful purpose in boiler water. However, the determination of the chloride ion, $(Cl)^{-}$, is both fast and accurate. The concentration of chloride, therefore, may be used to measure the total concentration of soluble salts in the boiler. If the chloride and the total concentration of soluble salts in the feedwater are known, their ratios may be used to calculate the concentra-

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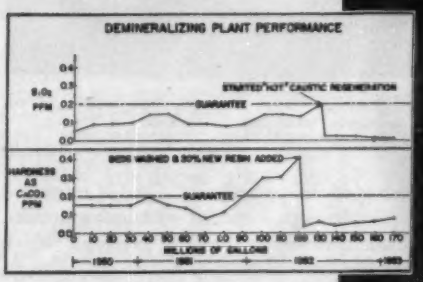
Waukegan Station Demineralization Plant

"CATEXER" "ANEXER" Demineralization Plant performance charts at Waukegan Station.



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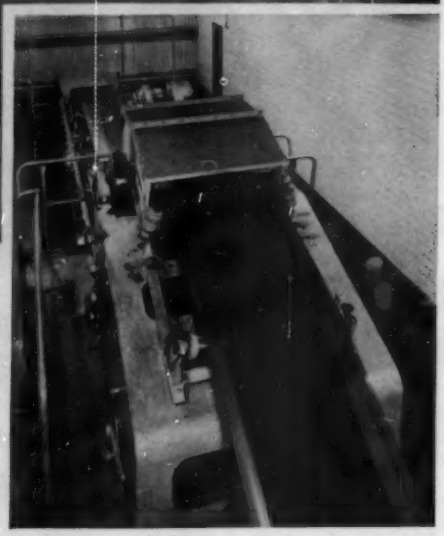

Self-propelled, hand reversing belt tripper in the powerhouse feeds coal to bunkers.

Bedding Boom Conveyor Prevents Segregation in New Coal Handling System

HARTFORD ELECTRIC LIGHT COMPANY
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How to stockpile coal 40-ft. high without separating the fines and causing compaction problems — this was a major consideration in designing a coal handling system for this new power plant. A boom conveyor which pivots both vertically and horizontally proved to be the answer. It can be adjusted to discharge directly on the top of the pile, regardless of height. This prevents coal segregation, allows good compaction and minimizes the danger of spontaneous combustion.

The boom conveyor is part of a complete conveying system designed and built by S-A. This system takes coal from track hoppers, feeds it by means of a plate feeder onto a slope conveyor belt and delivers it to a crushing house. From there, coal may go to the stocking-out system or through the crusher and onto a 642-ft. belt running to the top of the powerhouse. Coal is recovered from the stockpile through a special reclaiming hopper. This hopper loads a reversible flat belt conveyor which may feed either the crusher or deliver the coal directly to the powerhouse conveyor. Once in the powerhouse, the coal is transferred to a self-propelled belt tripper which loads the bunkers. The entire system operates at 300-tons per hour using 36-in. belts.

This is the second S-A Conveying System for Hartford Electric. Repeat orders like this have been earned by S-A's ability to design and manufacture dependable conveying systems that move coal at lowest cost per ton. If you have a coal handling problem, write for a free survey. No obligation.

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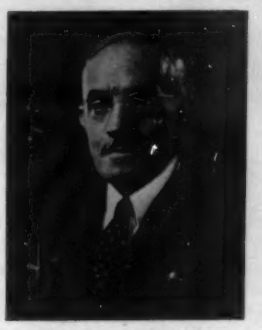
OBITUARIES

Dr. Gustav Egloff

DR. GUSTAV EGLOFF, one of the world's foremost petroleum scientists and director of research for Universal Oil Products Company, died April 29, in Chicago, following a brief illness. He was 69 years old.

Known and respected throughout the scientific world, the dynamic "Mr. Petroleum" was active almost to the end. He had visited his office just a few days before his death. As recently as April 15 he had been the keynote speaker at the 21st annual Engineers' Day celebration at the Colorado School of Mines in Golden.



Dr. Gustav Egloff

Born in New York of Swiss parents, Dr. Egloff attended Cornell University, and was graduated with the degree of Bachelor of Arts in 1912. He took graduate work at Columbia University, where he was awarded a Master of Arts degree in 1913 and a Doctor of Philosophy in 1915.

His proclivity for talking — either in casual conversation or on the rostrum — resulted in one of the longest answers ever given to a question in the history of Missouri jurisprudence. Testifying in St. Louis in a patent suit, Dr. Egloff was asked by an opposing attorney, "What do you know about emulsions?" Twenty-one days later Dr. Egloff finished his answer, and the other company settled out of court with his firm.

Dr. Egloff was the author of 650 articles relating to the petroleum industry and the chemistry of hydrocarbons, particularly the cracking and refining of oil. Approximately 300 patents had been credited to him in the United States and abroad relating to the processing of petroleum oil, coal, shale oil and chemical derivatives of hydrocarbons.

He was the author of a number of books which are widely used by petroleum scientists and technologists. Among them are "Thermal Reactions of Pure Hydrocarbons," "Catalysis," "Insomerization of Pure Hydrocarbons," "Alkylation of Alkanes" and a five-volume work

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"Physical Constants of Hydrocarbons."

Thus has passed from the scene a man whose voice one writer described as like a "rusty hinge" which condemned the "prophets of doom" who perpetually insisted that the world was wasting its oil resources. Dr. Egloff insisted right up to the last that tiny sea animals (like diatoms) are at work today under the ocean making deposits of petroleum faster than man can bring it out of the ground and convert it into gasoline.

The famed scientist is survived by his wife, Clara (nee Mellor). The couple had been married 40 years. There are no children.

NEW ENGINEERING BOOKS

Magnetic Cooling, by C. G. B. Garrett. First Edition, 110 pages, 5¾ by 8¼ in., cloth binding. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 1954. Price. $4.50.

Most of us familiar with the kinetic theory of heat, know that as we cool a substance, the molecular activity decreases. When we come in contact with a hot object, the pain we feel is the result of untold millions of molecules and atoms traveling at high speed, hammering away at the molecules and atoms of our skin. These molecules are not traveling as fast, and hence, there is a transfer of energy from the heated object to our skin. Conversely, when we touch a piece of ice, the opposite is true. The molecules of our skin are traveling at high speeds compared to the molecules of the ice and energy is therefore transferred from our skin to the ice. In either case, the sensation is somewhat the same.

As humans, we are most conscious of the temperature range between some 50 degrees below the freezing point of ice and that approximately around the boiling point of water. Temperatures of 100, 200, or 250 degrees below zero centigrade have little significance for us as far as our senses are concerned. One temperature feels about as cold as the other. At the temperature of liquid helium minus 270 degrees K, physiological response has little meaning. Curiously enough, as pointed out in this new book by Dr. Garrett, who is now with the Bell Telephone Laboratories, at that temperature, a substance still contains a great deal of thermal energy or, in the parlance of the physicist, at a temperature of one degree K, some systems are still in a state of almost complete disorder.

And as pointed out by Dr. Garrett, on a logarithmic scale, a temperature of say, 0.003 degrees K, is as far below one degree K as one degree K is below room temperature.

It is in this range of temperatures that is in the region of a fraction of a degree above absolute zero that magnetic cooling becomes effective. *continued on page 132*

An 18' butterfly valve disc is shown here during installation at Blakely Mountain in Arkansas. Note the streamlining of the welded disc.

Photos—Vicksburg District, Corps of Engineers

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With inside adjustment, the disc may be seated directly on the plate steel housing, as at Blakely Mountain, illustrated above, and as at Fort Peck, Montana. Here a 16 ft. dia. valve, recently tested after 14 years of service, had *less than ½ gpm leakage.*

SMS welded discs and housings assure greater freedom from the material defects of castings and permit more economical construction. The photo illustrates the streamlining possible with welded steel plate construction. This holds head losses and turbulence to a minimum.

SMS has designed and built butterfly valves in diameters from 3 inches to 18 feet, for service with operating heads up to 750 feet. For the assurance that your hydraulic equipment will meet or exceed specifications, you can rely on over three-quarters of a century of experience that SMS offers. For full information on butterfly valves, hydraulic turbines and accessories, write S. Morgan Smith Company, York, Pennsylvania.

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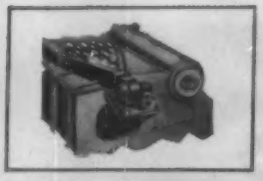
Rear mounted forced draft fan keeps firing front clear and provides proper flow of air to burner register preventing distortion of flame.



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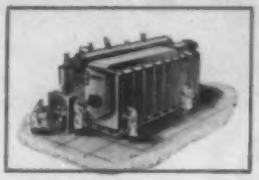
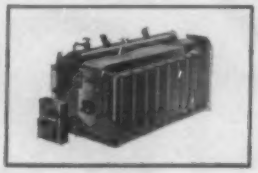
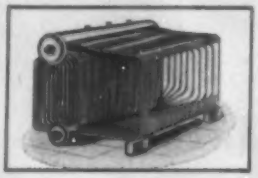


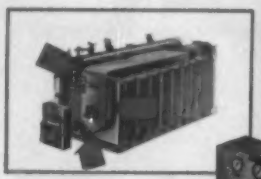
Rotary cup or steam assisted burners. Multiple burners where required. Burners for oil, gas, or both available on all units.



Tangent tube, waterwall furnace, all riser elements, discharge directly to steam drum. Drums extend both ends for maximum volume and releasing area.



Adequate inspection openings in casing. Refractory lined access door. Two manholes in each drum on sizes over 15,000 lbs. per hr.



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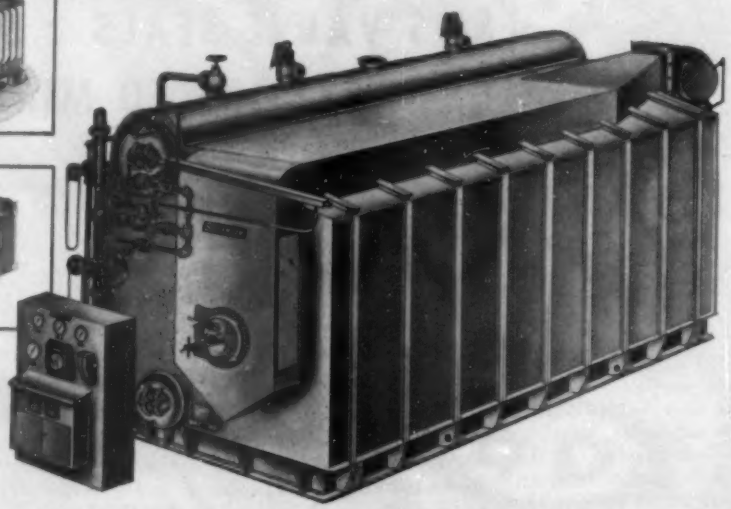

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STEAM GENERATORS

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ELECTRICAL EQUIPMENT

201 Motor-Generator Reference Book — Publication 51R7933 is a 50-pp booklet compiled to assist in the selection of motive power to handle most industrial applications. Neither textbook nor ordering catalog, this book provides a brief outline of the various types of motors, generators and motor-generator sets, telling their applications and operating requirements. Booklet is generously illustrated and includes performance data, ratings, information on methods of speed control. Allis-Chalmers Mfg. Co.

202 Electric Motors — Twenty types of company's motors are illustrated in 8-pp Bulletin 1878. Illustrated in natural color, the bulletin contains descriptions of Uni-closed, totally-enclosed, explosion-proof, Varidrive, Syncrogear, combination variable speed and internally geared units, right-angle worm gear, and other types. U. S. Electrical Motors Inc.

203 Motor Buying Guide — Bulletin GEC-1026, 28-pp, features company's standard a-c fractional and integral horsepower motors in most general use. Included are general- and definite-purpose fhp motors, and fhp gear motors. A section on selection of integral horsepower motors covers horsepower requirements, enclosures, starting current limitations, speeds, motor types, and selection of fuses and circuit breakers. Descriptions and specifications include single-phase, polyphase, totally enclosed fan cooled, and gear-type integral horsepower motors. Ratings, book prices, dimensions, frame numbers are included. General Electric Co.

204 Insulation Temperature-Resistance — Technical Publication 21T4, 16 pp, is an article on temperature-resistance characteristics of electrical insulation. Complete with tables and graphs, gives general information on variations in temperature characteristics, composite nature of electrical insulation, and practicability of temperature compensation. Other chapters deal with determining insulation constants for temperature correction factors, and a practical method of obtaining insulation temperature. James G. Biddle Co.

205 The Answers on Wiring — "20 Questions and 20 Answers on Safety m.i. Wiring" describes and illustrates characteristics and advantages of this new wiring system. A complete table of types, sizes, weights and lengths, as well as a partial list of users included. General Cable Corp.

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206 **Batteries for Control, Switchgear** — This company's PlastiCal (lead calcium) and PlastiCell (high-tensile alloy grid) batteries for control, switchgear, and auxiliary power are described as to design, application and performance in Bulletins CP-536 and CP-537. Specifications and dimensions included. C & D Batteries, Inc.

207 **High-Capacity Fuses** — Form HCS, 6 pp, describes fuses of unlimited interrupting capacity on voltages to 600, designed to afford protection for loads of 600 to 5000 amp. Includes test data, charts on opening time, current limiting effect. Bussmann Mfg. Co.

FUEL OILS, LUBRICANTS

208 **Versatile Industrial Oil** — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, their uses and physical properties. Standard Oil Co. (Ind.).

209 **Turbine Lubrication** — The special problems of turbine lubrication are discussed in 8-pp Bulletin TU-1. Tells how purifiers keep power units in service; discusses inhibited and uninhibited oils, company's process for reducing sludge formation within lubrication system. Illustrated with diagrams of typical installations. DeLaval Separator Co.

210 **Bearing Lubrication** — Vol. XL, No. 10 of this company's Lubrication magazine provides an excellent 12-pp article on industrial bearing lubrication. Illustrated with photos and drawings, text covers such subjects as bearing design; bearing surfaces; bearing overhaul; aspects of lubrication, including factors involved in choice of turbine oils and diesel lubricants, and the deleterious effects of moisture; and the life expectancy of bearing lubricants. Requirements of porous bearings are also discussed. The Texas Co.

211 **Petroleum Pitch** — This illustrated article on petroleum pitch as a boiler fuel stresses its low cost, other advantages. Explains combustion of pitch; discusses unloading method, burning, storage, fuel oil treatment, also precautions in handling hot pitch. Kor Corp.

BOILERS, GENERATORS

212 **Shop-Assembled Boiler** — Sixteen-pp Bulletin G-76 completely describes and illustrates company's Type FM water-tube integral-furnace boiler, made in standard sizes from 2900 to 28,000 lb of steam per hr, pressure to 250 psi. The Babcock & Wilcox Co.

213 **Packaged Boilers** — This 16-pp illustrated catalog describes manufacturer's new Type VP package boiler. Following a section of background information is an outline of the principal design features of these boilers, which are shop assembled and provide steam capacities from 4000 to 30,000 lb per hour. Space requirements are shown in a table along with typical specifications. Also described is control system. Combustion Engineering, Inc.

214 **Standard Boilers** — Eight-pp Bulletin WT-8 describes company's "S"

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But, there's a lot more to it than thickness. The film's most important function is protection against corrosion. By forming a nonwettable coating on all metal surfaces with which treated steam or condensate come in contact, Filmeen provides a protective, corrosion-inhibiting barrier between water and metal. In heat exchange equipment, the condensed steam treated with Filmeen then forms as spherical drops of water which resist adherence to the film surface, much the same as a drop of water will form into a small ball on a waxed surface. This phenomenon results in increased rate of heat transfer—which in turn saves money in power plant operation.

When steam condenses on untreated return lines, it forms a continuous layer of water that restricts heat transfer. You don't want that... it raises the cost of heat.

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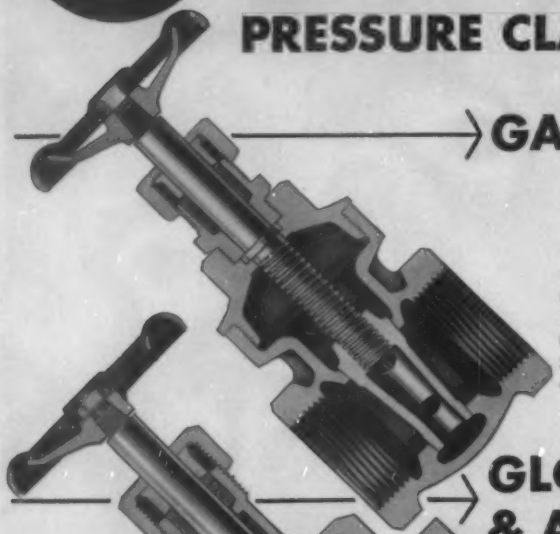
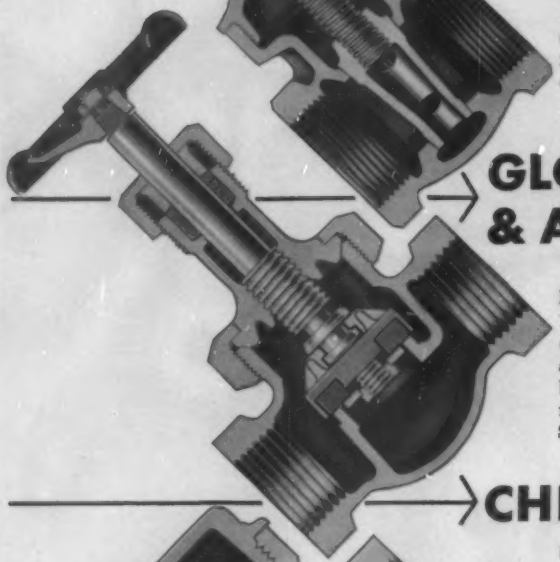


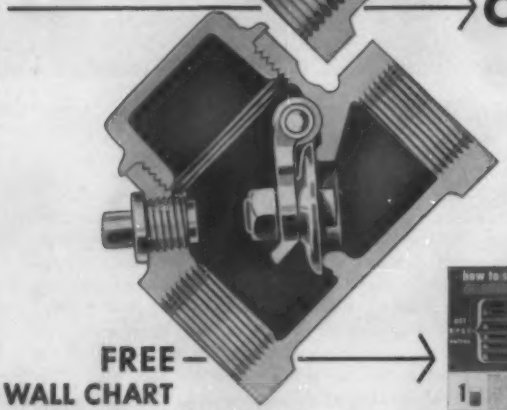
GATES

Fig. 86 illustrated, rated for 125 lbs., steam, 200 OWG, has stationary stem, solid wedge, screwed ends. Other 125 lb. models with screwed bonnet, rising stem, solid or split wedge.



GLOBES & ANGLES

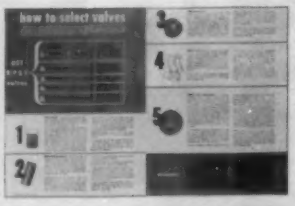
Fig. 1A Globe illustrated, rated 150 lbs. steam, 300 OWG, has renewable asbestos disc, union bonnet. Also furnished as Angle. Sizes ¼" to 3".



CHECKS

Fig. 198 illustrated, rated for 125 lbs. steam, 200 OWG. Other swing check valves in 150, 200, 300 lb. classes.

"Reliable Protection & Control"



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series of boilers with capacities ranging from 10,800 to 50,000 lb. Lists data and specifications on each of the models and sizes, and discusses general design features and special "S" type construction features. Wm. Bros Boiler & Mfg. Co.

215 Improved Steam Generator — Bulletin 2000, 28 pp, explains advance design features that distinguish this manufacturer's generator from other unit steam generators. Describes and illustrates engineering differences of component features. Also shows how these components are constructed, assembled and tested. Another section gives data, and dimensions for the units which range from 20 to 6000 hp. Preferred Utilities Mfg. Corp.

216 Steam Generators — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-tube boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Erie City Iron Works.

217 Steam Generator — This manufacturer's new Type D steam generator, a packaged unit for pressure firing with gas, oils or combination of fuels, is described in an 8-pp catalog. Gives complete data and dimensions on this water tube generator which is available in 17 sizes with capacities from 8000 to 40,000 lb of steam per hour. Fully illustrated, booklet explains economical steam production, low installation cost, other advantages. Superior Combustion Industries Inc.

218 Automatic Boilers — This bulletin describes 17 sizes of Powermaster packaged automatic boilers from 15 through 500 hp for steam process, steam and hot water heating service. Lists such advantages as three-pass design, forced draft and automatic controls. Describes firing equipment for light and heavy oils, gas; shows various fuel firing arrangements. Orr & Sembower, Inc.

WATER CONDITIONING

219 Handbook on Demineralizing — Comprehensive 40-pp Bulletin 5800-B compares various methods of water treatment, indicating the comparison between demineralizers and evaporators. It discusses the characteristics of the various types of available cation and anion exchange materials and offers data on operating cost of demineralizing. It tells when to use 2-bed, 3-bed, 4-bed, mixed or monobed demineralizers. It also indicates when decarbonators or vacuum deaerators should be installed. Cochrane Corp.

220 Modern pH and Chlorine Control — This 100-pp booklet gives details in color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on meaning of pH control, electrometric and colorimetric methods of determining pH and impurities in water; applications of water control in air conditioning; feedwater. W. A. Taylor & Co.

221 What's What on Ion Exchangers — Here are three booklets on ion exchangers: Nalcite HCR, a styrene type cation exchanger; Nalcite SAR, a strongly basic anion exchanger; and Super Nalcolite, a synthetic gel type zeolite for cation exchange. Tables and graphs explain performance of these water treating resins under various operating conditions. Physical characteristics, exchange capacities, re-

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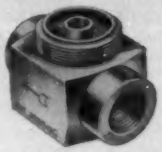

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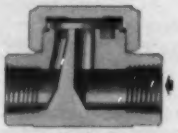

Only moving part, a hardened Solid Stainless Steel Disc, practically wear-proof!

2134-F

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No valve-closing mechanisms to wear or stick. Not affected by superheat, waterhammer, vibration, corrosive condensate. No critical clearances to choke. No gaskets to leak. Same trap for all loads and pressures 10-600 psi.

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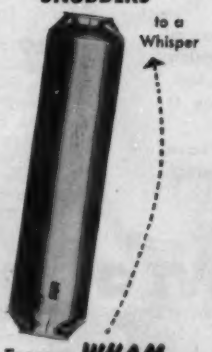

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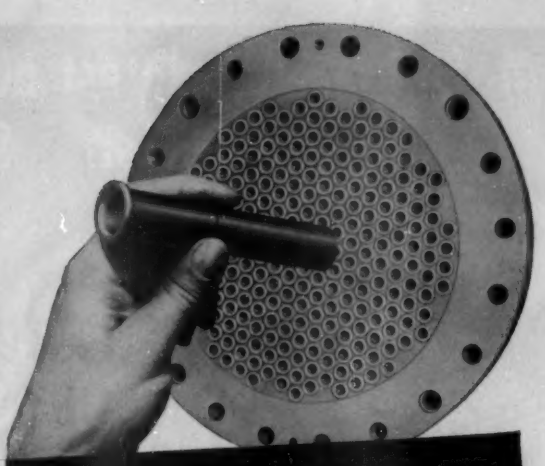

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2 Multiply Service Life of the Tube

In many cases, condenser tubes usually fail within the first few inches of the inlet. Wilson Condenser Tube Inserts actually restore these leaking tubes to service by sealing the deteriorated portion of the tube. Wilson Inserts also retard or eliminate the effect of inlet end erosion.

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Depend on these powerful, fast-acting cleaners to do a thorough job every time. There's a Wilson cleaner for all types of tube or pipe. All sizes in stock for immediate delivery.

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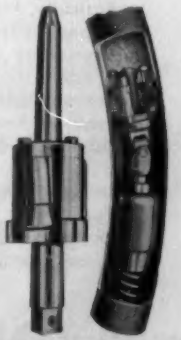
For re-rolling old tubes or installing new ones. Precision-made to insure firm seating. Self-feeding and parallel expansion for a particular trade.



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Basically, Instrof Tube Race is a channel equipped with tube clips permanently installed during manufacture. It is designed to accommodate from two up to six ¼" tubes or three or four ⅜" tubes.

The addition of Tube Race makes the present Instrof System capable of handling almost any tubing support problem which could conceivably arise. Instrof is relatively inexpensive too, and with low installation time and almost no maintenance it becomes an extremely economical system.

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generation techniques discussed Bulletin 57, 20 pp, is on Nalcite SAR; Bulletin 58, 28 pp, Nalcite HCR; Bulletin 59, Super Nalcolite. National Aluminate Corp.

222 Steam System Treatment — This bulletin on Coravol for prevention of corrosion explains theory of corrosion, application of organic amines to steam systems (Coravol process) and presents case histories of use in different types of plants and industries. Coravol is part of a complete technical service providing chemical formulas for treatment of water, steam, brine, fuel. Western Chemical Co.

223 Cracking and Embrittlement — Damage to equipment and possible injury to personnel that can result from cracking and embrittlement are discussed in 8-pp pocket-size Bulletin 290112. Outlines water system trouble spots and factors that can produce breakage and failure in components of heaters, boilers, condensers, process equipment, piping. Caustic and hydrogen embrittlement are discussed. Hall Laboratories, Inc.

224 Corrosion Treatment — "Corrosion Protection of Steam and Condensate Return Systems" is a folder on amine treatment for boiler and condensate systems. This treatment is described as affording surface protection of the metal as well as raising pH value of condensate. The Bird-Archer Co.

225 On Cooling Tower Wood — The protection of cooling tower wood is the subject of Technical Paper 130. Explains how chemical and bacteriological attack can be controlled by acid treatment and wood preservatives to kill fungi. W. H. & L. D. Betz.

227 Chemical Treating of Feedwater — Application Engineering Data Sheet D-54-3 discusses use of Hydrazine in treating feedwater for high pressure boilers. Tells how precise addition of this chemical to boiler feedwater maintains residual oxygen content at zero and also prevents ammonia accumulation in the system. Milton Roy Co.

228 Feedwater Treating — Bulletin 1855, 30 pp, features manufacturer's hot process Accelerator for treatment of boiler feedwater, illustrating and explaining its operation and advantages, also optional equipment. Contains excellent discussion of necessity for treatment of makeup water, selection of proper equipment. Also covers the limitations of hot process softening. Infilco Inc.

229 Water Conditioning Data Book — An excellent reference volume, Data Book 2478A contains 108 pp and presents a compilation of 78 chapters and tables. Subjects covered include hydraulics; impurities in water; chemical conversions; coagulant, acid and alkali dosages; chemicals used in water treatment; water treatment processes; boiler feed make-up requirements; alkalinity relationships; specific gravities; chemical reactions. Available to qualified power engineers, please state your job title when requesting this. The Permutit Co.

230 Demineralizers — Valuable information on demineralization is offered power engineers in comprehensive 24-pp Bulletin WC-111. Discusses demineralization in general and its advantages and applications. Basic types of demineralizers and their special uses are charted. Resins, piping, valves and accessory equipment are treated in detail. Book also provides

flow charts showing demineralization systems for chemical plants and power plants. Graver Water Conditioning Co.

231 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pretreatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

232 For Water Wells — An acidizing service for water wells, designed to increase water yield by enlarging formation channels and by removing scale deposits from pumps and screens is described in this folder. Lists advantages of this service, and cites some case histories. Dowell Inc.

233 For Industrial Water Softening — Greensand, zeolite and resinous exchange water softeners are described in 8-pp Form S-105. Discusses features and applications of each of these basic types and illustrates some installations. Includes capacity data and general specifications. Also describes and pictures controls for water softeners, pressure filters and deionizers. Illinois Water Treatment Co.

TUBING AND ACCESSORIES

234 Condenser Tubes — Excellent information on condenser tubes and their service life is given in this 40-pp illustrated booklet. Subjects discussed include corrosion of condenser and heat exchanger tubes, corrosion resistance and control, the selection of tube materials, and the composition and physical properties of company's alloys. Gives details on proper installation. Scovill Mfg. Co.

235 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

236 Nickel Pipe and Tubes — Bulletin T-17 is a 28-pp technical bulletin on the fabrication and design of nickel and high nickel alloy pipe and tubing, illustrated throughout by drawings and photos. Presents tables on mechanical and physical properties, ASME code requirements, recommended welding procedures. The International Nickel Co., Inc.

237 Tube Cleaners — Catalog 76-A provides 48 pp of information on manufacturer's line of tube cleaners. Following equipment selection and operating hints, this practical catalog describes and pictures cutter heads and drill heads, brushes, and motors, giving sizes, application information. Air valves, hose, lubricators are described. Thomas C. Wilson, Inc.

238 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

COAL, ASH HANDLING

239 Economic Coal Storage — How tractors establish safe, orderly coal handling is told in this 8-pp booklet. Stresses flexibility, low operating costs. Also shows

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Paracoil OIL-LEAK DETECTION SYSTEM

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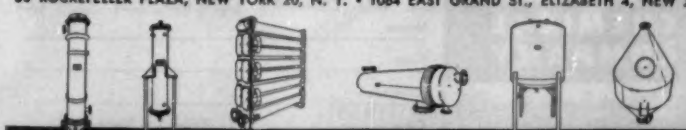

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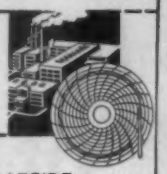

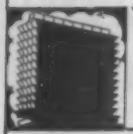

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how tractors speed storage reclamation and how a tractor-scraper combination offers plus benefits. Illustrated with action photos; pictures several models. Tractor Div., Allis-Chalmers Mfg. Co.

240 Burning Bituminous Coal — This 24-pp illustrated booklet is a compilation of numerous actual case histories of industrial plants and institutions which burn bituminous coal "the modern way." Stressing operating economy achieved, these case histories show problems overcome, equipment used, and savings realized. Bituminous Coal Institute.

241 Spreader Stoker — Sixteen-pp Bulletin 800 describes manufacturer's Type C-C RotoStoker, a relatively small spreader stoker offering continuous cleaning and ash discharge advantages of larger units, without need of a basement for ash-removal. Explains this and other operational advantages of the stoker, which is adapted to modern steam boilers with output capacities of about 5000 to 75,000 lb of steam per hour. Detroit Stoker Co.

242 Fly Ash Collection — The successful and economical separation of fly ash from boiler flue gases is discussed in 28-pp Catalog G405. Explains need for collection equipment and gives physical characteristics of fly ash. Describes company's Multiclone equipment as to principle of operation, performance and advantages. Western Precipitation Corp.

243 Coal Crusher — Company's WC and WS series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer Co.

244 Spreader Stoker Selection — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered. American Engineering Co.

PUMPS, PUMPING

245 Boiler Feed Pump — A barrel-type boiler feed pump for high pressure, high temperature service and designed to go on the line quickly without preliminary warm-up is the subject of 12-pp Bulletin 1525. De Laval Steam Turbine Co.

246 Gear Pumps — Besides presenting all of company's standard gear pumps, 24-pp Bulletin 17-A describes briefly some special types engineered for unusual requirements. Discusses design, construction and operation of the pumps; tells how they're used in the power and industrial fields. Drawings, action photos, capacity and pressure tables and performance data supplement the text. Booklet covers pumps ranging from 1 gph to 1000 gpm capacities. Schutte and Koerting Co.

247 For Abusive Pumping Jobs — Catalog 4906, 36 pp, covers centrifugal pumps for wide, industrial use and especially adapted to handling ashes, abrasive mixtures, slurries, hot and corrosive liquids. It describes several basic types: a horizontal shaft, single-stage side suction pump; a horizontal shaft, single-stage, rear-entrance automatic priming pump; vertical shaft pumps with standard, overhead and quill bearings for wet pit applications. Nagle Pumps.

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249 On Vertical Pumps — Sixteen-pp Bulletin B-505 describes and illustrates use of vertical industrial service pumps for liquid transfer from short settings in both industrial and process services. Points out advantages and describes three basic designs. Stresses versatility of the pumps due to design flexibility. Also gives general recommendations for obtaining optimum performance, and includes photos of typical installations. Peerless Pump Div., Food Machinery and Chemical Corp.

VALVES, TRAPS, PIPING AND ACCESSORIES

250 Check Valves — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

251 Lubricated Plug Valves — Revised Catalog PV-2, 12 pp, presents steel and semi-steel valves designed to offer quick shut-off of erosive or corrosive fluids. Explains advantages of the lubricated tapered plug design of these valves and pictures single gland, screwed gland, and bolted gland types. Also shows accessories. The William Powell Co.

252 Blow-Off Valves — Bulletin B-426, 20 pp, on blow-off valves for boiler pressures up to 400 lb wsp, contains installation recommendations, construction information on Yarway seatless and double-tightening blow-off valves. Gives full ordering data. Yarnall-Waring Co.

253 For Precise Control — Fifty-pp Catalog 17 covers manufacturer's line of disc valves and accessories, providing full selection and ordering data, materials of construction, sizes. Describes manual and automatic controls for these valves which, it is noted, are available in any metal which can be cast or welded. Minimum pressure drop, quick closure, simplicity and other advantages are discussed. R.-S. Valve Div., S. Morgan Smith Co.

254 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these

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valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are also discussed and the importance of stem operation is treated. Crane Co.

255 Valve Chart — Form 194, 24 pp, is a valve comparison chart, listing valve figure numbers of 15 major manufacturers and the OIC equivalent valve figure numbers. Compares variety of valves in ferrous and non-ferrous materials, describes different valve lines. The Ohio Injector Co.

256 Steel Gate Valves — Five types of Hancock general purpose steel gate valves for process and power piping systems are described in illustrated Bulletin 202 B, 12 pp. Material specifications, dimensions given, also service pressure ratings. Manning, Maxwell & Moore, Inc.

257 General Service Valves — Bulletin E-160, 16 pp, describes and illustrates design and construction of company's quick-operating valves, explaining their application to blow-off service and on chemical process, soot blowers, water column blow-down, and other types of pipe line. Everlasting Valve Co.

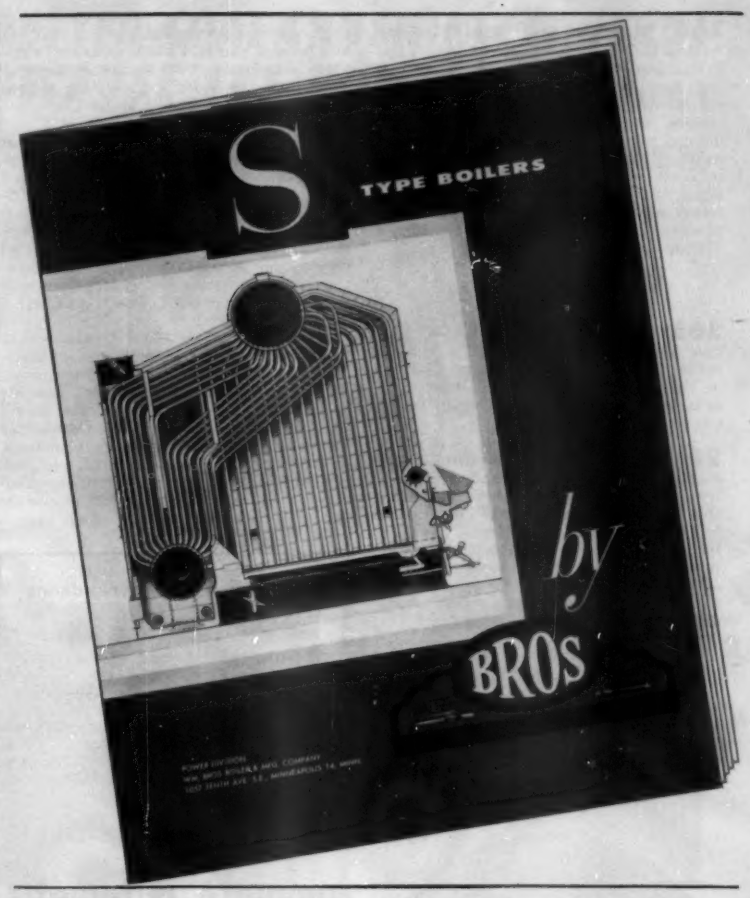
258 Industrial Valves — Condensed Catalog 105, 28-pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves designed for chain or extension operation in vertical lines. Also included is company's Mudwonder valve for abrasive fluids. Edward Valves, Inc.

259 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, trouble-shooting and repair. Armstrong Machine Works.

260 Steam Trap Solutions — Bulletin F. 151, 36 pp, is a newly revised edition of this company's well known booklet, "Solving Steam Trap Problems." Organized for easy reference, this illustrated booklet provides specifications and capacities of steam and float traps, air release valves, pipe line strainers. Tells how to calculate condensation loads and select traps for unit heaters, jacketed kettles, submerged surfaces. Gives pointers on installing traps. The V. D. Anderson Co.

262 Welded Fittings — Catalog 3 is a 36-pp ordering and engineering reference book on company's Weldolets for piping services. Gives data on butt-welding and socket welding Weldolets as well as on Thredolets for making threaded outlets. Typical installations are pictured; sizes, weights and prices provided. Also included are installation instructions and a technical section. Bonney Forge & Tool Works.

263 Improved Pipe Hanger — Twelve-pp Bulletin 153 describes company's Counterpoise pipe hanger for high temperature piping systems in steam generating stations, refineries and chemical plants. Tells how it offers efficient load supporting effort of constant value throughout entire range of travel as pipe expands or contracts because of temperature changes. National Valve & Mfg. Co.



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264 Stainless Steel Pipe Fittings — Bulletin S-3-55 describes company's 150 lb stainless steel pipe fittings for corrosive, high and low temperature service, including 90 deg elbows, tees, 45 deg elbows, crosses, couplings, reducers, pipe caps, unions, plugs and bushings. Presents dimensional specifications in sizes ⅛ to 2 in. in both screw end and socket welding types. Applications in chemical plants, refrigeration service, food and other process piping given. Watson-Stillman Fittings Div., H. K. Porter Co., Inc.

INSULATION

265 Insulating Material — Ultrafine, a thermal and acoustical insulation made of blown glass fibers, is presented in this bulletin. Shows it in use; gives data on properties, thermal conductivity. Gustin-Bacon Mfg. Co.

267 Data on Insulations — Insulation solutions for a wide range of temperature problems are charted in this folder. Provides brief descriptive information and tells forms available for high temperature applications, for intermediate temperature use, for hot and cold water and low pressure steam, for ice water and frigid temperatures, and other uses. Mundet Cork Corp.

INSTRUMENTS AND CONTROLS

268 Metering and Control Equipment — Sixteen-pp Bulletin 18 is a comprehensive catalog offering information on company's meters, control equipment and engineering services. It is written for engineers in power plants, public utilities and process plants. Fifteen measured variables common to power and process operations form the index for selecting appropriate equipment. Bailey Meter Co.

270 Electronic Feedwater Control — Three systems for the electronic regulation of boiler feedwater are explained briefly and diagrammed in Bulletin 52-1073-221. They include a single-element, two-element, and three-element system. Applications for each type are given, and descriptions of the flow measuring, receiving, level measuring elements, power unit and valve are included. The Hays Corp.

271 Indicating Flow Meter — Bulletin 18-A, 22-pp, discusses advantages, construction and operation of company's Type H indicating flow meter. Presents technical data on the principles and theory of fluid measurement and discusses orifice type meters and orifice meter principles. Offers examples of flow rate calculations. Schematic drawings and diagrams, tabulated technical data and specifications are included. The Meriam Instrument Co.

Postage-free cards for ordering catalogs are on page 120. You may also use the cards to order literature mentioned in the ads.

272 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

273 Ideas on Push-Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

OTHER EQUIPMENT

274 Steam Accumulator — How the steam supply and demand can be balanced by means of company's steam accumulator is told in Bulletin RA-52-8. Stresses reduced boiler capacity required and increased boiler efficiency afforded by the accumulator. Foster Wheeler Corp.

275 Good Operating Practices — Some 101 good suggestions for maintaining plant buildings and equipment are presented in the 12-pp new edition of this booklet. Well illustrated, contains latest recommendations for getting the best service out of insulations, packings, refractory products, roofings and friction materials. Johns-Manville.

276 Dust Collection — Aerodyne dust collectors in chemical processing and other industries are discussed in 8-pp Bulletin 171. Explains theory and design of collector system, includes drawings of

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the various types covered. The Green Fuel Economizer Co., Inc.

277 Tubing Support System — Twelve-pp Bulletin 254 presents a system for permanent and continuous support of instrument tubing. All items and fittings are illustrated by photo or dimensional drawing. Details of actual installations show some of the methods by which this system can be quickly and economically erected at the job site. Instrof Inc.

278 Belt Conveyor Carriers — Carriers designed for rugged jobs, exposure to dust and long service are the subject of illustrated Bulletin 453. Shows how their spun end rolls and welded steel frame contribute to extra strength and better balance. Stephens-Adamson Mfg. Co.

279 Refrigerator Condensers — Bulletin RC-2, 38 pp, utilizes drawings, tables and engineering data to show how to select proper type from company's line of ammonia and Freon condensers for refrigeration services. Illustrates horizontal multipass shell and tube types; vertical singlepass shell and tube types. Gives pipe sizes for ammonia and Freon lines; stands for condensers. Henry Vogt Machine Co.

280 Sheet and Plate Fabrication — Illustrated in 40-pp Bulletin F-3 are products of this manufacturer, and equipment used to produce special sheet steel and alloy parts. Shows control panels, switch gear housings, cubicles and other electrical enclosures, boiler air ducts, smoke breechings, tanks. The Kirk & Blum Mfg. Co.

281 Steam Condensers — Some recent additions to this company's power plant condenser installations are pictured and described briefly in this 24-pp booklet. Also included are an engineering section on condenser design factors, and sections devoted to air removal equipment, to steam condenser specialties, and to maintenance services available. Condenser Service & Engineering Co., Inc.

282 Selecting a Blowdown System — A simplified chart for calculating savings possible through heat recovery with a properly sized automatic continuous blowdown system is offered in this pamphlet. Chart is based on total dissolved solids in the boiler water and the permissible concentrations. Henszey Co.

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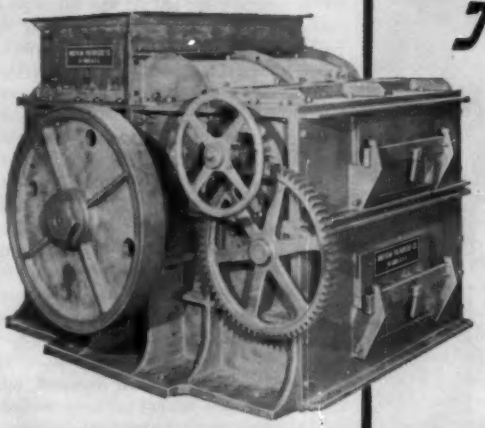

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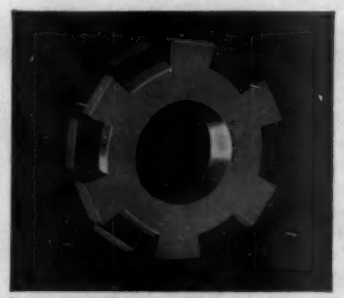

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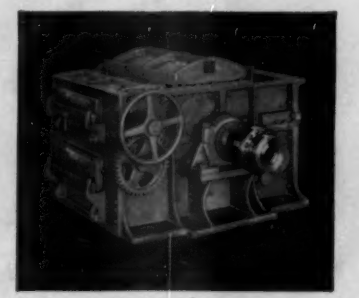

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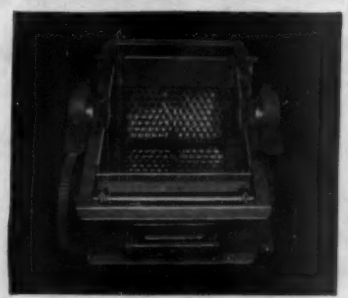

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Engineering Books

continued from page 116

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By such procedures, temperatures of 0.001 degree K, have been obtained, but the limit certainly has not yet been reached.

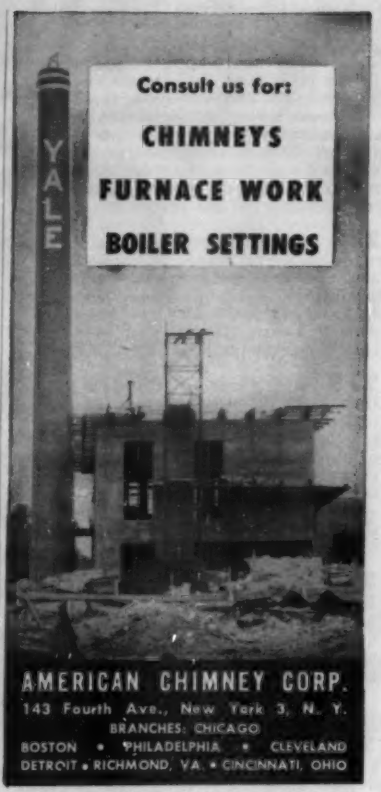
This, then, is what this book is about. It is the first book to appear in this significant and rapidly changing field since World War II. It gives a balanced review of work done in England, Holland, and the United States, and particular attention is given to the progress and understanding achieved in the last decade. The chapters on the thermal dynamic aspects of magnetic cooling are of special interest to physical chemists, and nuclear physicists should be intrigued by the possibilities of the technique in the study of directional properties of nuclei. Graduate students, solid state physicists and readers with a general background in modern physics will find in this monograph a stimulating account of the phenomena occurring under one of the extremes of accessible physical conditions.

Dr. Garrett was educated at Tonbridge School, England, and Trinity College, Cambridge. From 1946 until 1950, he was engaged in research in low temperature physics at the Royal Society Mond Laboratory, receiving the Ph.D. degree from Cambridge in 1950. In that year, he joined the faculty of Harvard University as an intructor in physics and since 1952 has held the position of member of Technical Staff at Bell Telephone Laboratories where he is currently engaged in a study of semi-conductor surfaces.

★ ★ ★

Essays in Science, by Albert Einstein. First Edition, 114 pages, 4¼ by 6¾ in.; cloth. Published by the Philosophical Library, Inc., 15 East 40th St., New York, N. Y. 1954. Price $2.75.

Albert Einstein is one of the most modest people in the world. In the letters and papers in this little book, he constantly refers to his accidental fame and his unearned popularity. So deep rooted is this feeling that he has merely tilled his own row, notwithstanding that that row was an inconceivably fertile one, that for many years his friends and



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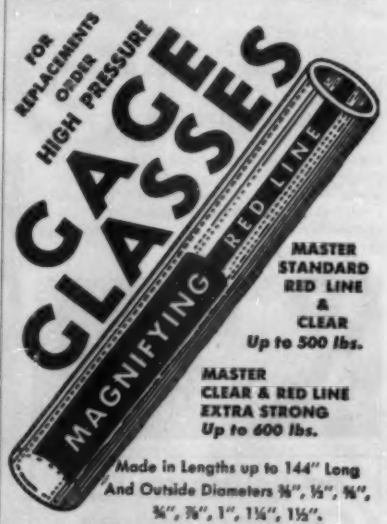
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intimates were unable to prevail upon him to publish his letters, papers and speeches, although opportunities and requests were showered on him.

The publishers admit that they do not know what good fortune had last prompted Albert Einstein to relax his attitude a little in permitting the publication of this little book. Perhaps he felt that in times like these, each man must sacrifice himself if he can help but a little to alleviate the horrible conditions that have fallen upon the world. If anything could break Einstein's silence, it was the threat of war in Europe.

Perhaps, too, it was in some small degree, a further extension of his modesty and a desire to show how much the scientific work has been prepared for, supported and amplified by less heralded collaborators. Whatever his reasons, the publication of these addresses is a welcome event, indeed, and they should be of great interest to people in all walks of life, scientists, engineers and laymen alike. The papers cover a wide variety of subjects as may be gathered from the following excerpts from the table of contents: Principles of research, On scientific truth, On the method of theoretical physics, Johannes Kepler, Clerk Maxwell's influence on the evolution of the idea of physical reality, On the theory of relativity, The problems of space, Ether and the field in physics, The cause of the formation of meanders in the courses of rivers, and, Of the so-called deer's law, The Flettner Ship.

Introduction to Nuclear Engineering by Raymond L. Murray. First Edition, 418 pages, 6 by 9 in. cloth, Prentice Hall, Inc., 70 Fifth Ave., New York, N. Y. 1954, Price $9.35.

This book on the techniques and methods of nuclear engineering is designed for those with a background in the fundamentals of conventional engineering, who want a working understanding of nuclear physics and atomic energy in their relation to practical problems.

Dr. Murray, who is Professor of Physics at North Carolina State College of Agriculture and Engineering, first defines what he means by nuclear engineering and describes its broad scope. As he points out, not only is the term applied to the nuclear reactor, its design, construction, testing and operation, but also to such related activities as the accumulation of nuclear fuel and other materials with unusual properties. It involves the handling of radioactive chemicals, the design of instruments for experimental particle detection, establishment of standards and practices in radiation protection and the use of isotopes for industrial and biological purposes. In this book, the author discusses the technology and problems of the use of atomic energy in all its phases.

Dr. Murray is well qualified to write this book. He attended the University of California as a graduate student, studying under Professor J. Robert Oppenheimer, and remained there as a research assistant in the Radiation Laboratory working under Prof. Ernest O. Lawrence on the development of electromagnetic separation of uranium isotopes. At present, he is Professor of Physics at North Carolina State College of Agriculture and Engineering, where he teaches undergraduate and graduate courses in reactor theory and reactor design in the nuclear energy program. This is the first school in the country to offer an undergraduate degree in this field.

★ ★ ★

A Dictionary of Electronic Terms. Edited by Gordon R. Partridge 72 pages, 6 by 9 in.; paper cover. Published by Allied Radio Corp., 100 N. Western Ave., Chicago, Ill., 1954. Price 25 cents.

This is a completely revised edition of a dictionary of electronic terms compiled under the direction of the technical staff of Allied Radio Corporation. It presents concise definitions of over 3500 terms used in radio, television, and industrial electronics. Definitions cover mostly modern techniques and equipment, but range from many words no longer in general use, retained for historic reasons, to the new language of color television and the electronics of nuclear physics. Over 150 illustrations and diagrams of components, equipment, and electronic circuits are included. Printed in a handy 6 by 9 format, this dictionary should prove helpful as a reference guide for everyone interested in electronics.

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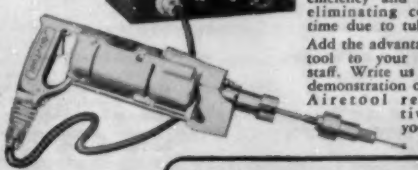

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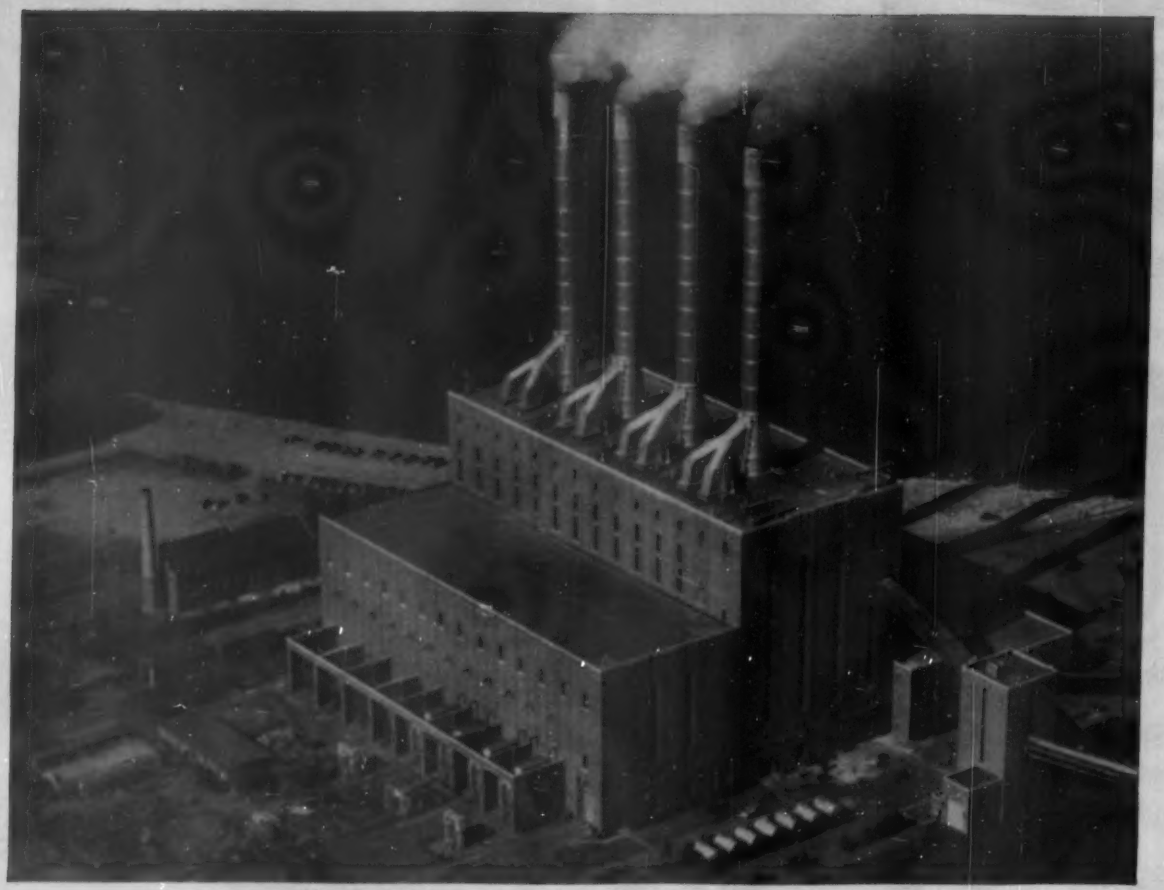

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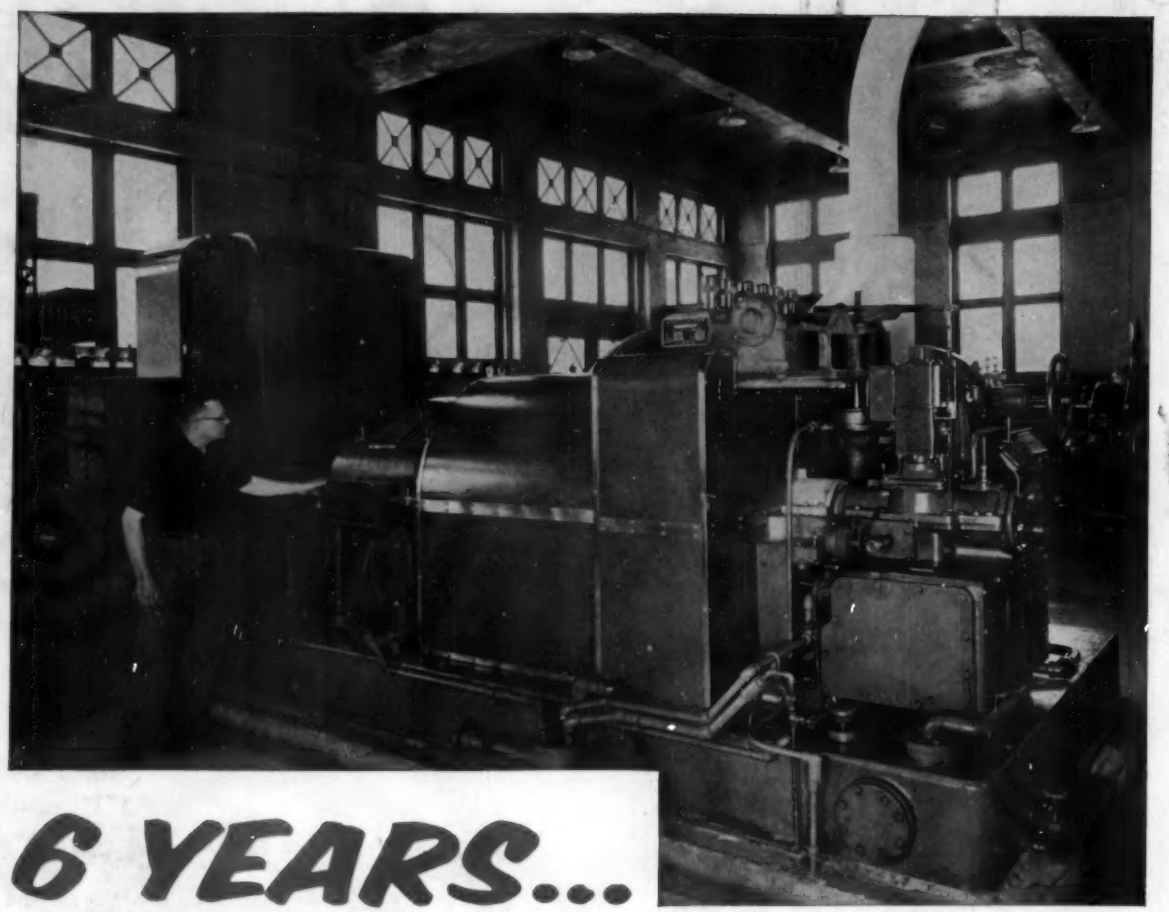

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